BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

SUBJECT: Experiment Scheduling for the AAP-1/AAP-2 Mission - Case 610

DATE: December 11, 1968

FROM: D. J. Belz

ABSTRACT

Timelines for each crewman throughout AAP-1/AAP-2 are constructed to investigate the mutual compatibility of crew-time requirements for experiments assigned to the mission. It is concluded that on the basis of crew-time, currently assigned experiments can be accommodated on the mission. This conclusion rests upon scheduling ground rules and experiment time requirements which are subject to revision as the program proceeds toward flight. At present, however, the results of this study indicate the desirability of incorporating all experiments currently assigned to AAP-1/AAP-2 into a baseline reference flight plan as an aid to continuing design efforts for all flight/ground systems required by the AAP-1/AAP-2 mission.

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MEMORANDUM FOR FILE

1.0 Introduction

This memorandum describes a study undertaken to investigate the crew-time profile resulting from the performance of experiments assigned to the AAP-1/AAP-2 mission. Timelines for each crewman throughout the entire 28 day mission were constructed from the crew-time requirements of each experiment, together with scheduling groundrules concerning meals, sleep periods, extravehicular activity, housekeeping, etc.

A major objective of this study was to schedule in their entirety all experiments assigned to the mission by NASA Headquarters in order to assess some of the implications of scheduling all assigned experiments. An analysis of the resulting timelines, discussed below, provides an indication of the extent to which current experiment time-requirements can be accommodated within the framework of mission groundrules currently being employed within the program and, in addition, provides a basis for reassessing those groundrules and the crew-time requirements of some experiments.

2.0 Experiments Assigned to AAP-1/AAP-2

Experiments assigned to the AAP-1/AAP-2 mission by ML Program Directive 3C* are:

a) AAP-1

M052, M056, S015, S027, M415, T018, D008

b) AAP-2

M402	M055	D021	T021
M487	D019	S065	T017
M051	D020	T003	D022
M050	T025	M479	D017
M052	S018	T013	S019
M056	T027	T018	S020
M058	M509	S009	M489
M053	M508	T004	M493
M018	T020	T023	M492

*Reference 1

Experiments S018, T018, T013, S009, T004, T023, S020, M489, M493, and M492 have subsequently been removed from the baseline for AAP-2;* experiment D017 has been terminated by the USAF.** Some of the experiments removed from the AAP-2 baseline remain under consideration as possible future candidates for reassignment to the flight.

Crew timelines constructed below are based upon the experiments assigned by Directive 3C, less D017 and the Litton-Suit portions of M508.

3.0 Crew-Time Requirements and Constraints

Crew-time requirements and constraints for each assigned experiment are summarized in this section. These experiment descriptions are based on the most recent documentation available from MSC and MSFC and are individually referenced in the following pages.

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*Reference 2
**Reference 3

Experiment M052 - "Bone and Muscle Changes"

1. Objective:

To measure changes in the musculo-skeletal system during orbital space flight by monitoring food and fluid intake and by analysis of excretion products.

2. Crew-Time Requirements:*

a. All urine eliminations of each crewman are to be measured and samples taken.

Urine collection: 6.5 minutes/man/collection.

Urine sample drying: 5. minutes/man/drying for setting up samples in dryer; 10. minutes/man/drying for stowage of dried samples.

b. Weighing of experimental diet food and fluids for each crewman including weighing of unconsumed food (M056): 3.2 minutes/man/meal.

c. Fecal eliminations of each crewman are mass measured, logged, and stowed (M056):

Fecal collection (once per man per day): 23. minutes/collection.

Operation of fecal dryer: 9. minutes/man/day.

d. Body mass of each crewman is measured daily (M058): 5. minutes/man/day.

*Reference 4

Experiment M056 - "Specimen Mass Measurement Device"

1. Objective:

To demonstrate the feasibility of mass measurement without gravity while validating the design and function of the mass measurement device.

2. Crew-Time Requirements:*

a. Checkout three standard mass measuring device units (once only): one man for 9. minutes.

b. Perform standard mass measurements:
one man for 21. minutes early in mission
one man for 21. minutes in middle of mission
one man for 21. minutes late in mission.

c. See description of Experiment M052.

*Reference 5

Experiment S015 - "Effects of Gravity on Single Human Cells"

1. Objective:

To determine the effects of prolonged zero gravity on single human cells.

2. Crew-Time Requirements:

a. Unstow and prepare for operation - one crewman for 30. minutes.*

b. Activate photography cycle - one crewman for 3. minutes at intervals of 6. hours.*

c. Activate feed cycle - one crewman for 3. minutes at intervals of 12. hours.*

d. Fix and label cycle for Biopack Number 1 (BP1):*†

Actuate; reactuate 30±2 minutes later; reactuate 60±2 minutes later. Performed by one man on Day 6.

e. Fix and label cycle for Biopack Number 2 (BP2):*†

Actuate; reactuate 60±2 minutes later; reactuate 30±2 minutes later. Performed by one man on Day 10.

NOTE: Experiment S015, which is currently planned to utilize hardware intended for an Apollo mission, ends on Day 10. The principal investigator is currently defining the modifications necessary to extend the experiment's duration to the mission duration (Reference 8).

*Reference 6
†Reference 7

Experiment S027 - "Galactic X-Ray Mapping"

1. Objective:

To perform a high sensitivity survey of galactic x-ray sources for a portion of the celestial sphere.

2. Crew-Time Requirements:* NONE

*Reference 6

Experiment M415 - "Thermal Control Coatings"

1. Objective:

To determine degradation intensities of thermal control coatings resulting from the launch environment and rocket plume impingement.

2. Crew-Time Requirements:* NONE

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*Reference 6

Experiment T018 - "Precision Optical Coatings"

1. Objective:

To improve flight mechanics and trajectory data during the first fifty seconds of flight by tracking the vehicle with a laser beam reflected from the IU.

2. Crew-Time Requirements:* NONE

*Reference 9

Experiment D008 - "Radiation in Spacecraft"

1. Objective:

To measure radiation dose rates and time integrated dose entering the Command Module.

2. Crew-Time Requirements:*

a. One astronaut performs experiment while passing through the South Atlantic Anomaly on three separate orbits: 7. minutes/orbit.

b. One astronaut performs experiment while outside the South Atlantic Anomaly on three separate orbits: 16. minutes/orbit.

*Reference 10

Experiment M402 - "Orbital Workshop"

1. Objective:

To demonstrate the feasibility of providing a habitable shirtsleeve environment within an orbiting S-IVB spent stage.

2. Crew-Time Requirements:*

a. Activation of Airlock Module and Multiple Docking Adapter: 10. man hours.

b. Activation of Orbital Workshop prior to Experiment M487: 26.5 man hours.

NOTE: For scheduling it is assumed that the total work time can be broken up arbitrarily into segments having reasonable durations.

*Allocation employed in Reference 7

Experiment M487 - "Habitability/Crew Quarters"

1. Objective:

To establish and evaluate habitable quarters and associated equipment as an aid to future mission design.

2. Crew-Time Requirements:*

105. man hours.

NOTES:

1. Estimates of time required to perform Experiment M587 vary considerably: the Experiment Implementation Plan for M487, dated September 20, 1967, specified a crew time requirement of 44. man-hours; Reference 6 states that "approximately three days total mission time" is required.

2. For scheduling it is assumed that the total work time can be broken up arbitrarily into segments having reasonable durations.

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*Allocation Employed in Reference 7

Experiment M051 - "Cardiovascular Function"

1. Objective:

To detect alterations in the cardiovascular function which may degrade performance of the cardiovascular system during space flight or after return to the earth's surface.

2. Crew-Time Requirements:*

Two of the three crewmen serve as experiment subjects; the third crewman functions as an observer. The experiment is to be performed a minimum of four times on each subject with a three day interval between performances on the same man. Each performance requires the observer and a subject simultaneously for 63. minutes.

3. Crew-Time Constraints:*

a. The crewman designated as the observer in this experiment must be a physician.

b. Lower body negative pressure (LBNP) must not be applied to a subject within three hours after a meal.

c. LBNP must not be applied to a subject within two hours following his performance of Experiment M053.

d. Experiment is not to be performed on a subject who is unduly fatigued.

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*Reference 11

Experiment M050 - "Metabolic Costs of Inflight Tasks"

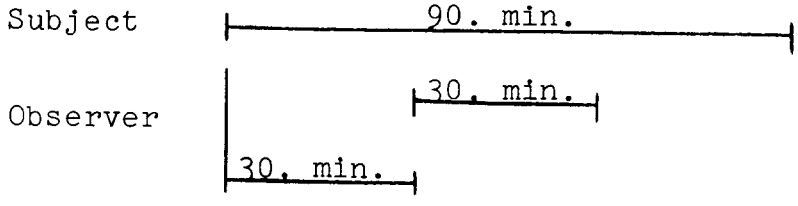
1. Objective:

To determine if man's metabolic effectiveness in doing mechanical work is progressively altered by exposure to the space environment and to determine the metabolic cost of activities when man is effectively deprived of gravity.

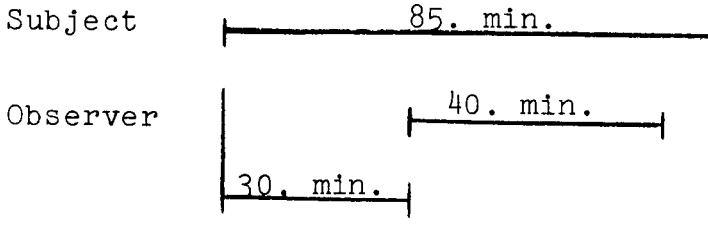
2. Crew-Time Requirements:*

Each crewman will perform each of modes A, B, and C three times during the mission - once early, once in the middle, and once late in the mission. Each mode requires a subject and observer as follows:

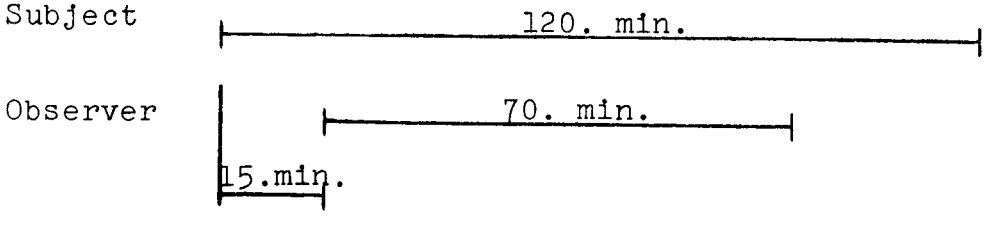
a. Mode A - Resting Metabolic Rate and Bicycle Ergometry



b. Mode B - Unsuited Maintenance and Constant Work Task



c. Mode C - Suited Maintenance and Constant Work Task



3. Crew-Time Constraints (All Modes):*

Experiment is not to be performed within 2 hours after performing M018, within 3 hours after a meal, or within 2 hours after severe exercise.

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*Reference 12

Experiment M058 - "Body Mass Measurement Device"

1. Objective:

To demonstrate the feasibility of body mass measurement in a "low gravity" environment; to validate the design of the body mass measurement system; and to support Experiment M052.

2. Crew-Time Requirements:*

See description of Experiment M052.

3. Crew-Time Constraints:*

Perform body mass measurements following sleep period each day.

*Reference 6

Experiment M053 - "Human Vestibular Function"

1. Objective:

To determine susceptibility of astronauts to motion sickness or illusions having a vestibular origin while in a weightless condition; to determine if prolonged absence of gravity will produce changes in gravity receptor activity.

2. Crew-Time Requirements:*

a. Spatial Localization Test

To be performed by each crewman once early, once in the middle, and once late in the mission. Each performance requires a subject and observer simultaneously for 55. minutes. For each group of tests, all three crewmen must be tested within a 16. hour period.

b. Ear Canal Test

To be performed by each crewman one day before and one day after performing the spatial localization test. Each performance requires a subject and observer simultaneously for 40. minutes.

3. Crew-Time Constraints:*

Performance of M018 and M051 should be scheduled to avoid the carry-over of test response symptoms to M053 and vice versa.

*References 6 and 13

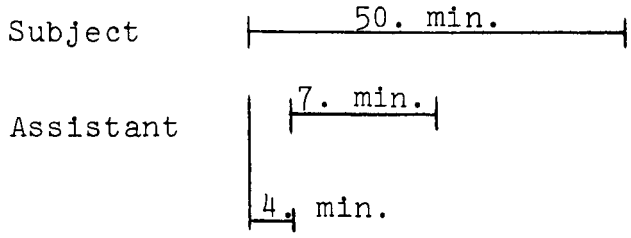
Experiment M018 - "Inflight Vectorcardiogram"

1. Objective:

To measure electrocardiac potential during weightlessness and in the immediate post-flight period.

2. Crew-Time Requirements:*

Experiment is performed on each crewman once every other day.



3. Crew-Time Constraints:*

Experiment is not to be performed within 3. hours after a meal or within 1/2 hour after severe exercise.

*Reference 14

Experiment M055 - "Time and Motion Study"

1. Objective:

To determine the effectiveness with which in-flight tasks are performed by astronauts when compared with ground-based performances, as measured by time and motion studies.

2. Crew-Time Requirements:*

The time required to setup and operate a camera and lights is incorporated in the crew timelines of experiments to be photographed.

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*Reference 15

Experiment D019 - "Suit Donning and Sleep Station Evaluation"

1. Objective:

To evaluate the MOL sleep station; to evaluate timelines and techniques for donning the MOL pressure suit in a zero-G environment.

2. Crew-Time Requirements:*

a. A subject and observer are required for the following sequence:

Don MOL pressure suit with liquid cooled garment: 29. minutes (including 11. minutes of M055).

D020 suited tasks.

Doff suit and initiate suit drying: 24. minutes.

b. A subject and observer are required for the following activity:

Don and doff MOL suit with constant wear garment and initiate suit drying: 35. minutes.

c. Enter MOL sleep station (shirtsleeve); evaluate; egress and secure station: one man for 24. minutes.

3. Crew-Time Constraints:*

Suit drying operation requires 1. hour and is unattended by crew after initiation.

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*Reference 16

Experiment D020 - "Alternate Restraints Evaluation"

1. Objective:

To evaluate the capability of the MOL foot, leg, pelvic, and waist restraints to position an astronaut while performing assigned tasks.

2. Crew-Time Requirements:*

a. One man is required for the following sequence:

Setup	21. minutes
Fixity Task Board/Fixity Restraints Operations	75. minutes
Transition	7. minutes
M508 Task Board/MOL Restraints Operations	108. minutes
Transition	16. minutes
M508 Task Board/M508 Restraints	108. minutes

b. One subject and one monitor are required for the following sequence:

D019 MOL Suit Donning with LCG	
Fixity Task Board/Fixity Restraints Suited Operation	93. minutes
Transition	7. minutes
M508 Task Board/MOL Restraints	113. minutes
Transition	16. minutes
M508 Task Board/M508 Restraints	113. minutes
Stow Restraints and Tools	12. minutes

*Reference 17

Experiment T025 - "Coronagraph Contamination Measurements"

1. Objective:

To determine composition of local atmosphere about the spacecraft and to identify changes in that atmosphere caused by thrusters, waste dumps, and vehicle orientation.

2. Crew-Time Requirements:*

One man is required for the following sequence:

Setup experiment in scientific airlock	24.5 minutes
Perform photography sequence during entire sunlit portion of 4. noncon-secutive orbits	
Remove and stow experiment.	25.5 minutes

*Reference 18

Experiment S018 - "Micrometeoroid Collection"

1. Objective:

To collect small micrometeoroids; to measure the flux of large micrometeoroids; to carry out biological exposure and collection experiments.

2. Crew-Time Requirements:*

Setup in Scientific Airlock, 16 exposures of 25. minutes duration each, stowage and data recording: one man for 8. hours.

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*Reference 6

Experiment T027 - "Contamination Measurement"

1. Objective:

To measure sky background due to solar illumination of contaminating particles about the spacecraft; to measure changes in the optical properties of lens, mirror, and grating components resulting from surface contamination.

2. Crew-Time Requirements:*

a. Setup sample array system in scientific airlock and deploy: one man for 34. minutes.

After 5 days, retract and stow sample array system: one man for 73. minutes.

b. Setup photometer system in scientific airlock and deploy: one man for 55. minutes.

Perform observations for 32. minutes in sunlight and 32. minutes in earth's shadow on each of four succeeding orbits.

Retract and stow photometer system: one man for 47.4 minutes.

*Reference 19

Experiment M509 - "Astronaut Maneuvering Equipment"

1. Objective:

To evaluate three extravehicular maneuvering units and to obtain better understanding of EVA maneuvering problems.

2. Crew-Time Requirements:*

This experiment is performed in four "runs", with each run on a separate day and at least two days between each run to minimize overboard dumping of cabin atmosphere through a pressure relief valve.

Run Number 1	Crewmen A, B for 235. minutes simultaneously.
Run Number 2	Crewmen A, C for 225. minutes simultaneously.
Run Number 3	Crewmen A, B for 235. minutes simultaneously.
Run Number 4	Crewmen B, C for 160. minutes simultaneously.

*Reference 20

Experiment M508 - "Astronaut EVA Hardware Evaluation"

1. Objective:

To evaluate EVA hardware in a zero gravity environment.

2. Crew-Time Requirements:*

This experiment is performed in six runs, with each run on a separate day and at least two days between successive runs to minimize overboard venting of the cabin atmosphere.

Deploy experiment equipment: one man for 1.5 hours.

Run Numbers 1, 2, and 5 - Block II Suit: two men simultaneously for 4.5 hours/run.

Run Numbers 3, 4, 6 - Litton Hard Suit: two men simultaneously for 4.5 hours/run.

Stow experiment equipment: one man for 1.5 hours.

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*Reference 21

Experiment T020 - "Jet Shoes"

1. Objective:

To determine the feasibility of the jet shoe concept for extra-vehicular maneuvering by using the Foot-Controlled Maneuvering Unit (FCMU).

2. Crew-Time Requirements:*

This experiment is performed in three runs with each on a separate day to minimize overboard dumping of cabin atmosphere. Each run requires two men simultaneously for the following durations:

Run Number 1:	151. minutes
Run Number 2:	87. minutes
Run Number 3:	67. minutes

*Reference 22

Experiment D021 - "Expandable Airlock"

1. Objective:

To validate the design of an expandable airlock intended for operational applications on future manned spacecraft; to evaluate the compatibility of the astronaut with the airlock during ingress and egress maneuvers.

2. Crew-Time Requirements:*

Deployment of expandable airlock is actuated from within the spacecraft. Evaluation of airlock, including ingress/egress by one astronaut and sample retrieval requires 2-hours of EVA by two crewmen.

3. Crew-Time Constraint:*

Required photography is to be performed in sunlight.

---

*Reference 6

Experiment S065 - "Multiband Terrain Photography"

1. Objective:

To obtain spectral reflectance of selected areas and high quality photos for geologic, geographic, and oceanographic study by simultaneous exposures with four different film/filter combinations.

2. Crew-Time Requirements:*

This experiment will require one crewman for a total of ∿10. hours. Specific times at which S065 is to be performed will be determined during the flight by weather "and other constraints."

*Reference 6

Experiment T003 - "In-flight Nephelometer"

1. Objective:

To determine aerosol particle size, quantity, and distribution as a function of time within the spacecraft; to collect aerosol particles for post-flight analysis.

2. Crew-Time Requirements:*

One crewman is required for 45. minutes on each of 14. separate days, the first of which is as early as possible in the mission. Measurements are to be made in the CM, MDA, AM, and OWS each time the experiment is performed.

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*References 6 and 23

Experiment M479 - "Zero Gravity Flammability"

1. Objective:

To ignite various solid materials in a controlled atmosphere under weightless conditions to determine propagation rates and the effectiveness of extinguishing agents.

2. Crew-Time Requirements:*

One man is required for the following sequence:

Setup and checkout	130. minutes
100 tests, including film changes and gas sampling @ 8.8 minutes/test =	880. minutes
Stowage	27. minutes

NOTE: All 100 tests need not be performed in a single run.

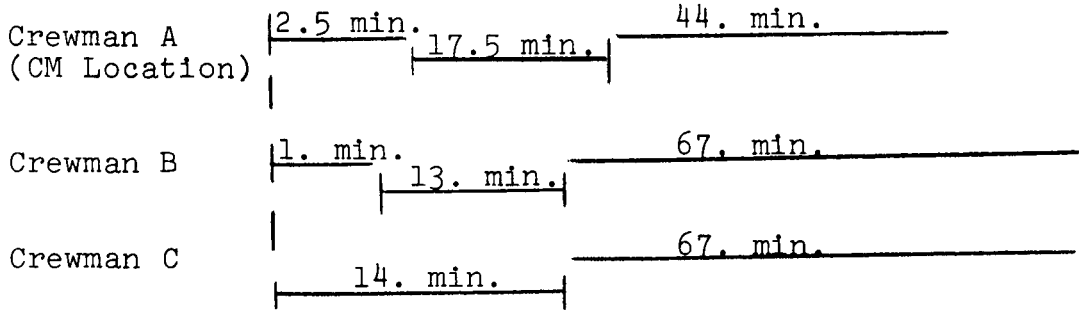
*Reference 24

Experiment T013 - "Crew Vehicle Disturbances"

1. Objective:

To measure the effects of crew motion on manned spacecraft dynamics in order to define allowable crew activities during experiments requiring extreme pointing accuracies or spacecraft stability.

2. Crew-Time Requirements:*



*Reference 25

Experiment S009 - "Nuclear Emulsion"

1. Objective:

To study the radiation and particle environment in space as a function of time.

2. Crew-Time Requirements:*

One man is required for the following sequence:

Install and activate experiment: ∿1/2 hour.

After 18 or more days, deactivate and stow: ∿1/2 hour.

*Reference 6

Experiment T004 - "Frog Otolith Function"

1. Objective:

To determine the otolith response of frogs during a prolonged period of weightlessness.

2. Crew-Time Requirements:*

No scheduled crew activities.

*Reference 26

Experiment T023 - "Surface Adsorbed Materials"

1. Objective:

To collect samples of materials which adsorb on the spacecraft exterior during various stages of insertion into orbit.

2. Crew-Time Requirements:*

Samples are to be recovered on the fifth day of the mission during an EVA period of 50. minutes duration.

3. Crew-Time Constraints:*

Perform EVA sample recovery operations during the sunlit portion of an orbit.

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*Reference 27

Experiment T021 - "Meteoroid Velocity"

1. Objective:

To measure the impact velocity and penetration depth of meteoroids into soft aluminum.

2. Crew-Time Requirements:*

Jettison experiment cover and activate electronics module: one man for "a few seconds."

3. Crew-Time Constraints:**

Deploy experiment as soon as possible after launch. (Undeployed experiment partially blocks radiator.)

NOTE: Panels are to be recovered via EVA on AAP-3 and AAP-3A missions.*

*Reference 6
**Reference 28

Experiment T017 - "Meteoroid Impact and Erosion"

1. Objective:

To measure the meteoroid erosion rate on a vycor glass surface; to determine the effects of meteoroid erosion on optical properties of glass; to verify Pegasus data obtained with 1.5 mil aluminum plates.

2. Crew-Time Requirements:*

Deploy experiment: one man for 15. minutes.

3. Crew-Time Constraints:**

Deploy experiment as soon as possible after launch. (Undeployed experiment partially blocks radiator.)

NOTE: Samples are to be recovered via EVA during the AAP-3A mission.***

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*Time allocation employed in Reference 7
**Reference 28
***Reference 6

Experiment D022 - "Expandable Structures for Recovery"

1. Objective:

To evaluate two types of expandable glass-fiber panels after exposure to the packing, storage, launch, and orbital environments.

2. Crew-Time Requirements:*

a) Deploy during an EVA period "early in mission:" 30. minutes.

b) Recover samples during an EVA period "late in mission:" 60. minutes.

3. Crew-Time Constraints:*

Deployment and associated photography must be done during the sunlit portion of an orbit.

NOTE: Two sample panels will be recovered via EVA during the AAP-3A mission.*

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*Reference 6

Experiment S019 - "Ultraviolet Stellar Astronomy"

1. Objective:

To survey ultraviolet radiation from stellar sources.

2. Crew-Time Requirements:*

Unstow experiment, install in scientific airlock, perform experiment during 9. night passes, remove experiment and stow: ∿5 hours. (Number of crewmen required is yet to be determined.)

*Reference 6

Experiment S020 - "X-Ray/UV Solar Photography"

1. Objective:

To photograph the sun in the extreme ultraviolet and x-ray portions of the electromagnetic spectrum.

2. Crew-Time Requirements:*

The following sequence is performed by one crewman once early in the mission and once as late as possible in the mission:

Setup experiment in scientific airlock; required time not stated.

Obtain three 30. minute exposures, one 15. minute exposure, one 8. minute exposure, and one 5. minute exposure.

Remove and stow equipment: required time not stated.

3. Crew-Time Constraints:*

Obtain photographic exposures from 5. minutes after spacecraft sunrise to 5. minutes before spacecraft sunset during any orbit.

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*Reference 6

Experiment M489 - "Heat Exchanger Service"

1. Objective:

To test the performance of wicking evaporative heat exchangers under weightless conditions for comparison with earth-based (1g.) performance.

2. Crew-Time Requirements:*

The following sequence is to be performed by one man:

Setup experiment: 2. hours

Perform 45. experiment runs @ 1/2 hour/run

Stow experiment: 1/2 hour

NOTE: After initial setup, M489 can be performed in 1/2 hour increments of time.*

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*Reference 29

Experiment M493 - "Self Contained Electron Beam Welding"

1. Objective:

To demonstrate welding and determine material behavior during welding under conditions of vacuum and weightlessness.

2. Crew-Time Requirements:*

This experiment requires one man for 1-3/4 hours.

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*Reference 6

Experiment M492 - "Joining of Tubular Assemblies in a Space Environment"

1. Objective:

To join stainless steel tubing by exothermic brazing and to determine the effects on joint strength of vacuum and weightless conditions during brazing.

2. Crew-Time Requirements:*

This experiment requires one crewman for 3-1/2 hours.

*Reference 6

4.0 Mission Parameters

4.1 Orbital Parameters

The launch, docking, and deorbit sequence of the AAP-1/AAP-2 mission employed in this study was based on the MSC Preliminary Baseline Reference Mission* (PBRM) and the ML-15 launch schedule:**

Initial circular orbital altitude: 220 nm***
Orbital inclination: ~29°
Launch date of AAP-1: August 1971
[Assumed date: August 15]
Launch time-of-day for AAP-1: 3:20 PM EST
Completion of CM-SM/MDA docking: 6:40 GET†
Initiation of Deorbit Maneuver: 661:40 GET
CM Landing: 662:10 GET

Experiments D021, D022, T023, T025, and S020 are restricted in whole or in part to performance during the sunlit portions of one or more orbits. Experiment S019 is to be performed only during spacecraft night. Experiment T027 requires "day" and "night" portions of the spacecraft orbital path for performance. Experiment D008 requires a knowledge of whether the spacecraft is inside or outside the South Atlantic anomaly. These experiments are scheduled below in accordance with spacecraft day/night cycles and the spacecraft ephemeris as calculated by Mr. A. B. Baker (Bellcomm) using a modification of the Bellcomm Apollo Simulation Program (BCMASP) with orbital and launch parameters as described above.

Recent baseline changes have revised the orbital inclination to 35° and the initial circular orbital altitude to 210 nm.†† CM/SM availability may "slip" the launch dates for AAP-1/AAP-2 projected in the ML-15 schedule; the phasing of day/night cycles and the scheduling of associated experiments shown in the crew activity sequence below, together with D008, must be regarded as only "representative" until firm launch schedules are defined.

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*Reference 30
**Reference 31
***Baseline change subsequent to PBRM publication
†GET ≡ Ground Elapsed Time (Hours:Minutes) measured from AAP-1 liftoff
††Reference 2

4.2 Pressurization Sequences

The time required for initial pressurization of the Orbital Workshop is currently estimated to be 16 hours.* The time required for initial pressurization of the Airlock and Multiple Docking Adapter (AM/MDA) was determined as follows. The current MSFC design of the MDA provides for retaining ∿1.5 psia of N_2 from a ground purge in the AM/MDA for use as a diluent gas in the orbiting vehicle's cabin atmosphere. To attain nominal atmospheric conditions in the AM/MDA (70% O_2, 30% N_2, P_{TOTAL} = 5 psia), ∿39.#O_2 must be added in orbit from the cryogenic supply in the SM which is to be designed to supply O_2 for initial cluster pressurization at 20.#/hour.** Thus, initial pressurization of the AM/MDA will require delivery of O_2 for 1.95 hours. Two hours are allocated for this activity in the present study.

5.0 Scheduling Guidelines and Assumptions

Sleep periods, meals, and the experiments described above were scheduled, where possible, in accordance with the following guidelines and assumptions:

1. Orbital Workshop (OWS) passivation will be completed prior to the launch of AAP-1.

2. The crew shall enter the Command Module at KSC two hours prior to liftoff of AAP-1.

3. Each crewman shall be allocated at least 8 continuous hours of sleep during each mission day. Typically, two crewmen shall sleep simultaneously, the third while the first two are awake.

4. A minimum of 3-1/2 hours per crewman on each mission day shall remain unassigned between completion of OWS activation and initiation of deorbit preparations in order to provide 1-1/2 hours per man per day for personal housekeeping and 2 hours per man per day for systems housekeeping. Personal housekeeping includes rest, clothing changes, and other hygienic requirements. Systems housekeeping includes monitoring of spacecraft systems performance.

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*Airlock Data Book, McDonnell Douglas, May 27, 1968, cited in Reference 32

**Reference 32

5. Each crewman shall be allocated 50 minutes for "breakfast," 1 hour for "lunch," and 1 hour for "dinner" during each mission day. Where possible, subject to experiment requirements and sleep cycle restrictions, meals shall be eaten simultaneously by the three crewmen.

6. One day per week shall be reserved for rest and mission evaluation, subject to experiment requirements.

7. At least one crewman, awake or sleeping, must be in the Command Module throughout the mission.

8. Experiments M050, M051, M052, M056, M018, M055 and M058 shall begin as soon as possible following MDA activation.

9. Allocate 2-1/4 hours of preparation time prior to an EVA and 3/4 hour post-EVA time for all crewmen.

10. Allocate a maximum duration of 3 hours for any one EVA.

11. All crewmen must be awake during an EVA.

12. During an EVA one crewman shall be in the Command Module (soft-suited), the other two being outside the vehicle's pressurized volume.

13. Days 27, 28, and 29* are reserved for deactivation of the OWS/AM/MDA, deorbit housekeeping and stowage, deorbit, entry, and recovery.

6.0 Subscheduling of Experiments

Crew-time requirements of some of the experiments to be scheduled are defined in ways that relate two or more experiments, or an experiment with meals or other activities. Such experiments were "subscheduled" prior to timelining the entire mission, as discussed below.

6.1 Experiments M052, M056, and M058**

1. Allocate time for urine collection (M052: 6.5 minutes/man) and mass measurement of food and fluids consumed (M056: 3.2 minutes/man) during each meal for each crewman.

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*Day 1 is defined as beginning 14-1/2 hours prior to AAP-1 liftoff in order to include preflight crew activities in the schedule. The scheduled mission duration from AAP-1 liftoff to CM landing is 27 days 14 hours 10 minutes.

**Bone and Muscle Changes, Specimen Mass Measurement Device, and Body Mass Measurement Device.

2. Allocate time for body mass measurements (M058: 5 minutes/man) prior to breakfast and time for fecal collection (M056: 23 minutes/man) following breakfast for each crewman from completion of MDA activation to initiation of MDA deactivation.

3. Allocate 5 minutes during each lunch period of one crewman to initiate drying of urine (M052) and feces (M056). Assume fecal dryer is capable of simultaneously drying all urine and fecal samples collected in a 24-hour period.

4. Assuming the fecal dryer shuts off automatically when drying is completed, allocate 5 minutes during each dinner period of two crewmen (M052, M056) for removing, logging, and stowing dried samples.

5. The following durations provide the time required for each meal including M052, M058, and the portions of M056 described in items 1 through 4 immediately above:

Breakfast:	1-1/2 hours
Lunch:	1-1/4 hours
Dinner:	1-1/4 hours

6. Experiments M052, M056, and M058 are completely scheduled for performance during meal periods as indicated in Item 6, with the exception of initial checkout and standard mass measurements of M056, and unscheduled urine/fecal collections and measurements (M052, M056).

6.2 Experiments D021, D022, T023*

1. Allocate one EVA period on Day 5 (T023) or as soon as possible thereafter consistent with scheduling requirements of higher priority experiments.

2. Allocate a second EVA period late in the mission (D022).

3. Required durations for each crewman:

First EVA Period
EVA Preparation: 2-1/4 hours
EVA
D021: 120 minutes
T023: 50 minutes
D022 Deployment: 30 minutes
Post EVA: 3/4 hour

Second EVA Period
EVA Preparation: 2-1/4 hours
EVA
D022 Sample Recovery: 1 hour
Post EVA: 3/4 hour

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*Expandable Airlock; Expandable Structures for Recovery; Surface Adsorbed Materials.

4. The above allocation satisfies all crew-time requirements of D021, D022, and T023 on the AAP-1/AAP-2 mission.

6.3 Experiments D019 and D020*

Elements of D019 and D020 Tasks will be grouped to integrate task performance within each experiment, such groups being defined below as "Modes."

1. Mode A:

A subject and observer are required simultaneously for the following continuous sequence:

Don MOL suit with LCG (D019)	29. minutes
Fixity Task Board/Fixity Restraints Operations (D020)	93. minutes
Transition (D020)	7. minutes
M508 Task Board/MOL Restraints Operations (D020)	113. minutes
Transition (D020)	16. minutes
M508 Task Board/M508 Restraints Operations (D020)	113. minutes
Stow Restraints and tools (D020)	12. minutes
Doff suit and initiate suit drying	24. minutes
Total Duration of D019/D020 Mode A =	407. minutes

2. Mode B:

A subject and observer are required for the following operations:

Don and doff MOL suit with CWG and initiate suit drying (D019)	35. minutes

*Suit donning and Sleep Station Evaluation; Alternate Restraints Evaluation

3. Mode C:

One man is required for 24. minutes to enter the MOL sleep station, evaluate the station, egress, and secure station (D019): 24. minutes, including 9. minutes of M055

4. Mode D:

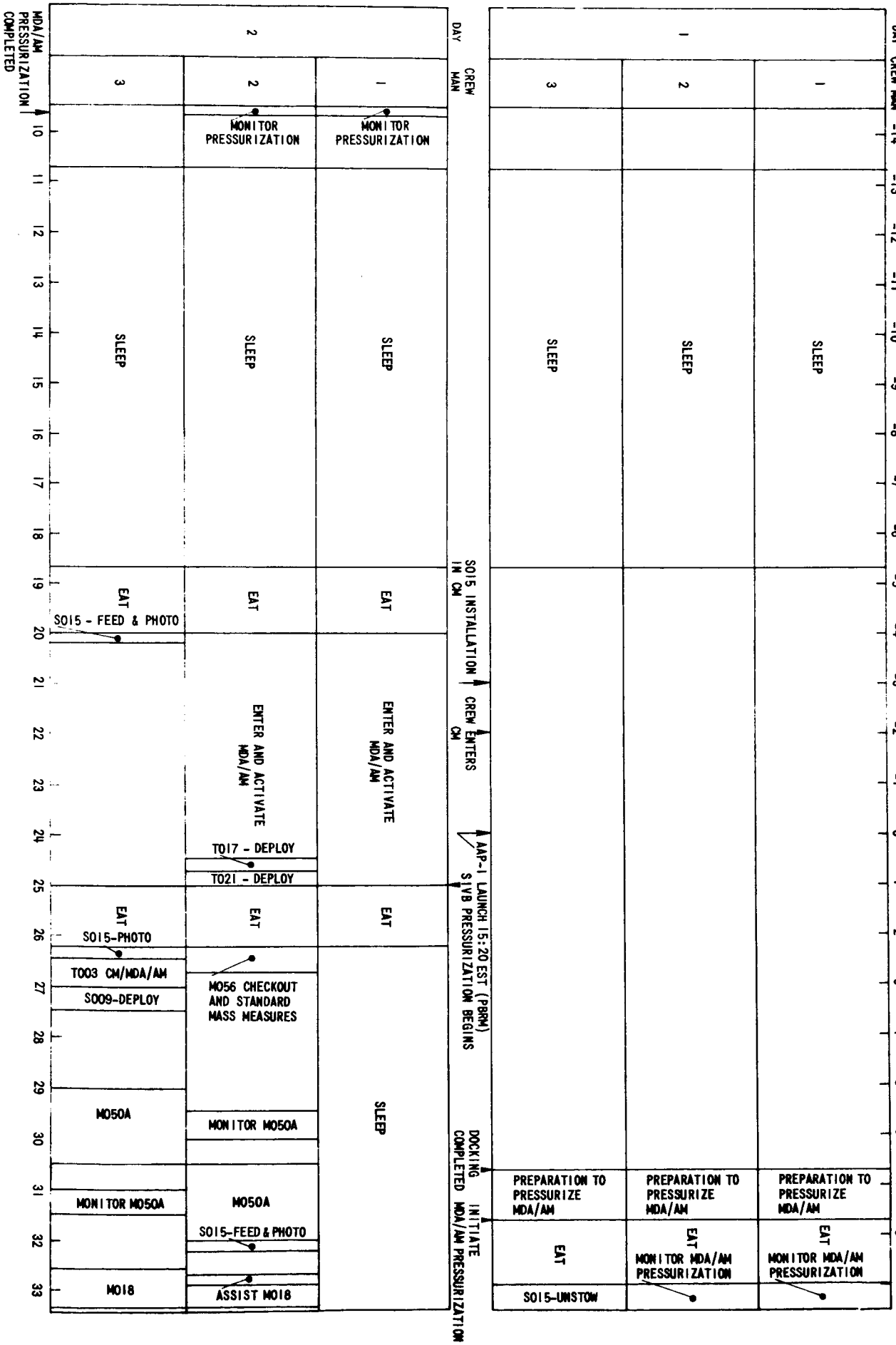
One man is required for the following sequence:

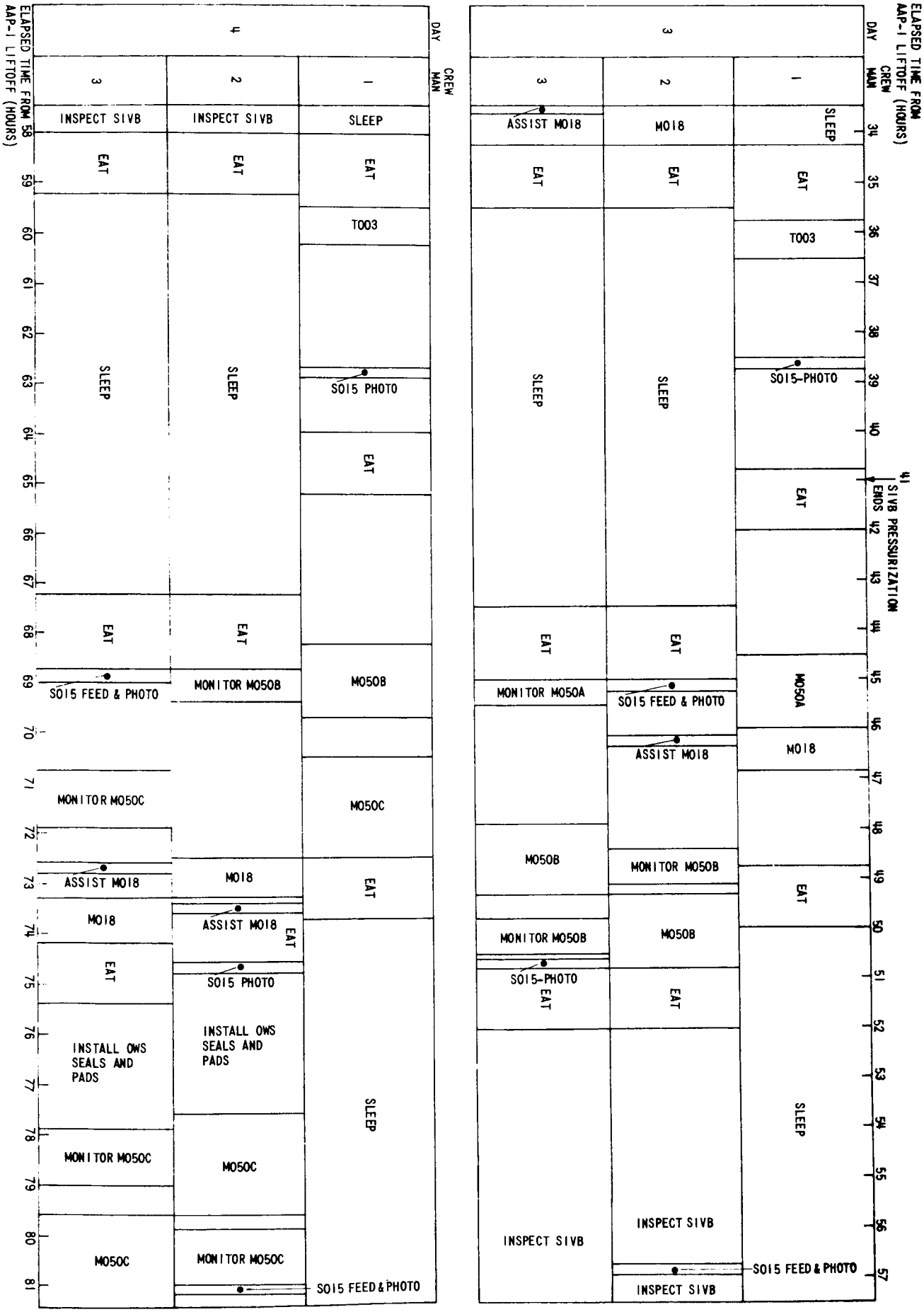
Setup (D020, M055)	21. minutes
Fixity Task Board/Fixity Restraints Operations (D020)	75. minutes
Transition (D020)	7. minutes
M508 Task Board/MOL Restraints Operations (D020)	108. minutes
Transition (D020)	16. minutes
M508 Task Board/M508 Restraints Operations (D020)	108. minutes
Stow Restraints and tools (D020)	24. minutes
Total Duration of Mode D (D020) =	359. minutes

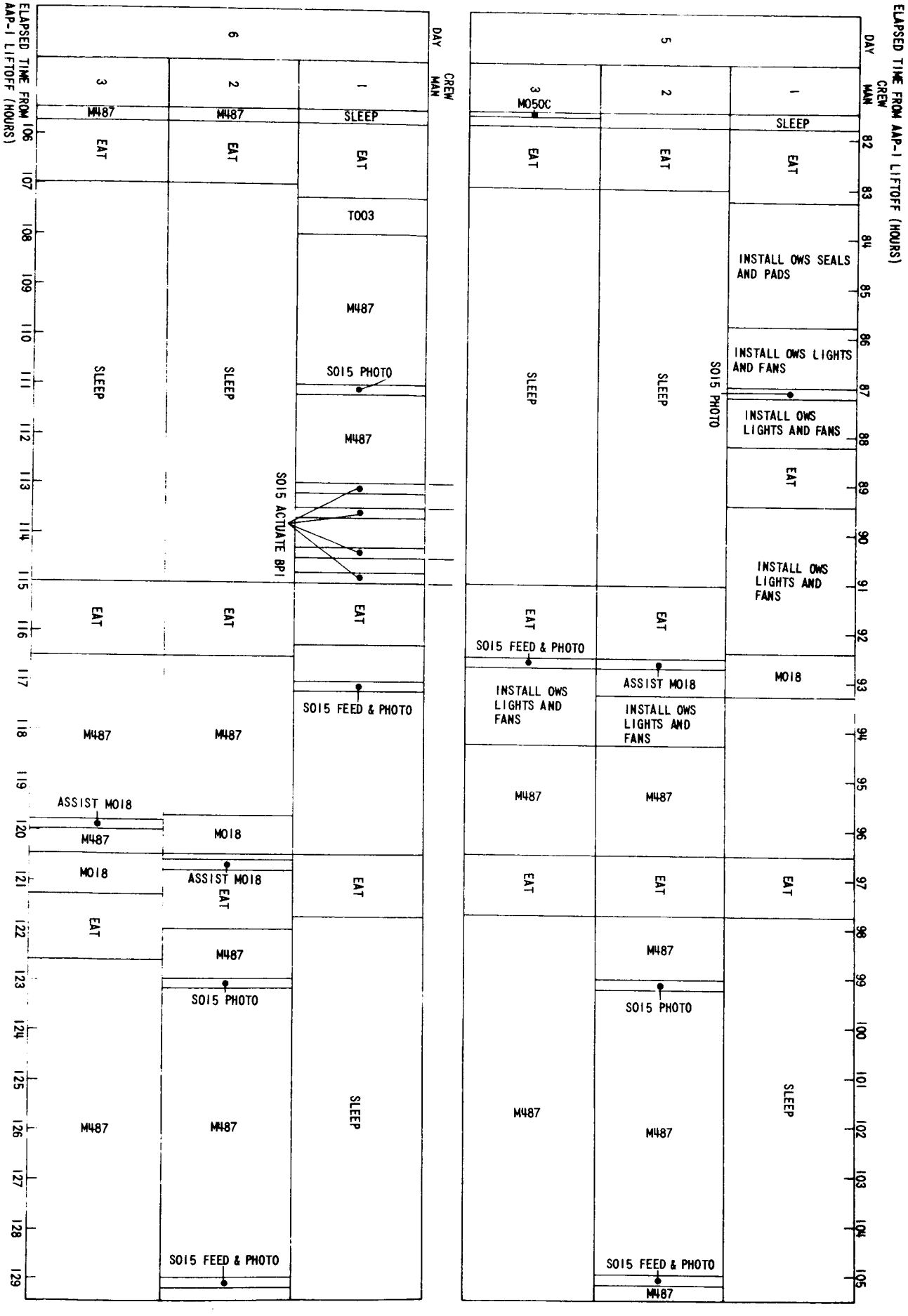
7.0 Crew Activity Sequence

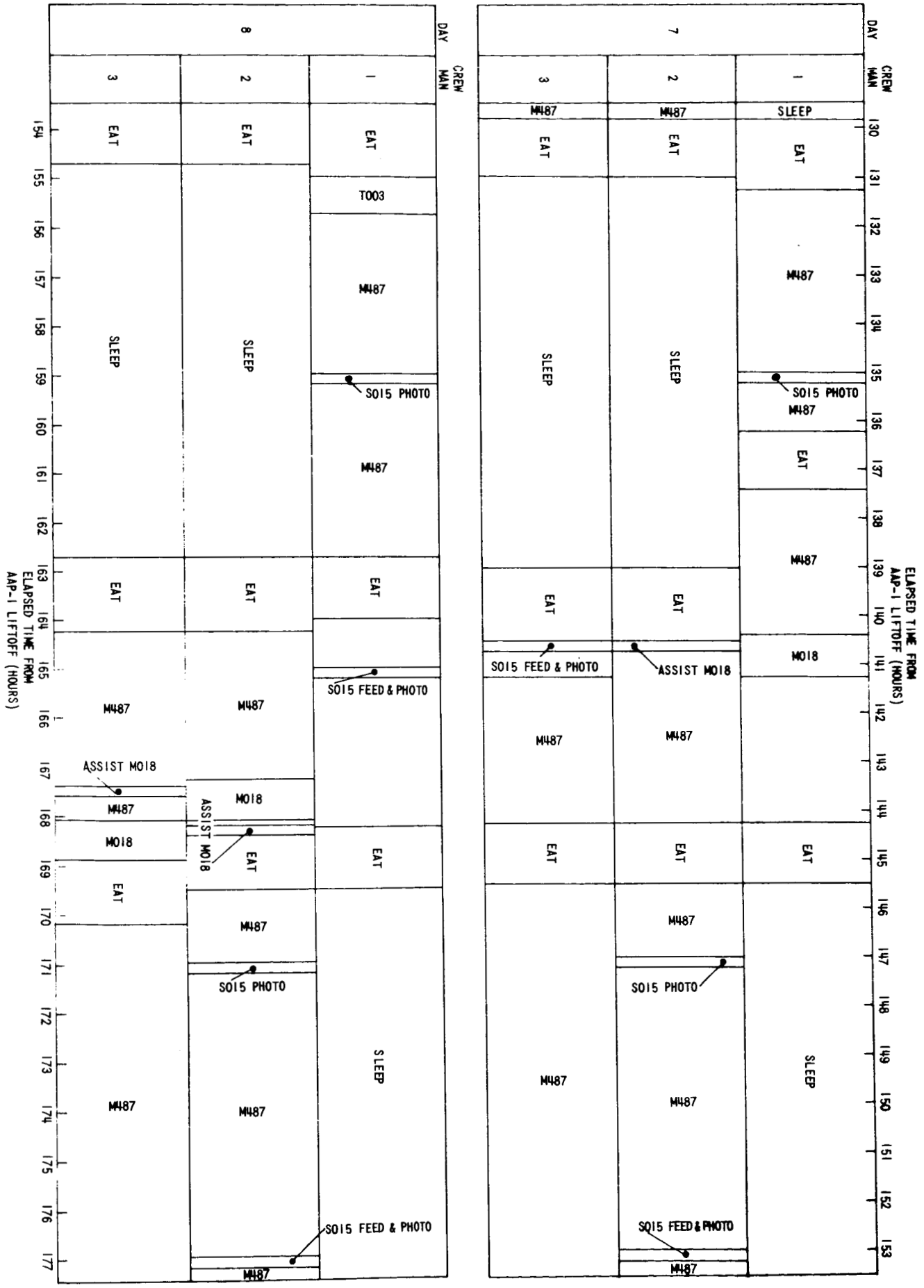
Crew Timelines constructed from the above scheduling groundrules, experiment requirements, and mission description are presented in the following pages. The activities of each crewman during two mission days is shown on each page. The first mission day, as noted previously, has been defined as commencing 14-1/2 hours prior to liftoff in order to indicate crew activities immediately preceding flight. The timescale accompanying each day indicates the number of elapsed hours measured from liftoff of AAP-1. Each crew activity is identified by a brief descriptive designation, e.g., "sleep," "M018," etc., and an indication of start and stop times. Marginal notes supplement the individual timelines as required.

It must be stressed that the experiment requirements, groundrules, and mission parameters do not uniquely define a single mission timeline for the crew. What has been attempted, therefore, is the construction of timelines which satisfy the crew-time requirements and constraints imposed by experiments, groundrules, and mission parameters in a logically self consistent manner. This has been largely but not entirely accomplished; violations of requirements and constraints which appeared to be unavoidable in attempting to schedule all assigned experiments are discussed in the next section of this memorandum.


ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
-14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9
1
2
3
SLEEP
PREPARATION TO PRESSURIZE MDA/AM
EAT
MONITOR MDA/AM PRESSURIZATION
S015-UNSTOW
DOCKING COMPLETED
INITIATE MDA/AM PRESSURIZATION
AAP-1 LAUNCH 15:20 EST (PBRM)
S IVB PRESSURIZATION BEGINS
CREW ENTERS CM
S015 INSTALLATION IN CM
DAY
CREW MAN
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1 25 26 27 28 29 30 31 32 33
MDA/AM PRESSURIZATION COMPLETED
MONITOR PRESSURIZATION
SLEEP
EAT
S015 - FEED & PHOTO
ENTER AND ACTIVATE MDA/AM
T017 - DEPLOY
T021 - DEPLOY
S015-PHOTO
T003 CM/MDA/AM
S009-DEPLOY
M050A
MONITOR M050A
M056 CHECKOUT AND STANDARD MASS MEASURES
S015-FEED & PHOTO
M018
ASSIST M018


ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
4
3
2
1
INSPECT SIVB
INSPECT SIVB
SLEEP
EAT
EAT
EAT
T003
SLEEP
SLEEP
S015 PHOTO
EAT
EAT
EAT
S015 FEED & PHOTO
MONITOR M050B
M050B
MONITOR M050C
M050C
ASSIST M018
M018
M018
ASSIST M018
EAT
EAT
S015 PHOTO
INSTALL OWS SEALS AND PADS
INSTALL OWS SEALS AND PADS
MONITOR M050C
M050C
M050C
MONITOR M050C
S015 FEED & PHOTO
SLEEP
ASSIST M018
M018
EAT
EAT
SLEEP
SLEEP
MONITOR M050A
S015 FEED & PHOTO
M050A
ASSIST M018
M018
M050B
MONITOR M050B
EAT
MONITOR M050B
M050B
S015-PHOTO
EAT
EAT
INSPECT SIVB
INSPECT SIVB
S015 FEED & PHOTO
INSPECT SIVB
SLEEP
S015-PHOTO
EAT
T003
EAT
SLEEP
EAT
41 SIVB PRESSURIZATION
EMOS


ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
1
2
3
5
6
SLEEP
EAT
M050C
INSTALL OWS SEALS AND PADS
INSTALL OWS LIGHTS AND FANS
INSTALL OWS LIGHTS AND FANS
INSTALL OWS LIGHTS AND FANS
INSTALL OWS LIGHTS AND FANS
SO15 PHOTO
SO15 FEED & PHOTO
ASSIST M018
M018
M487
T003
SO15 ACTUATE BPI


DAY
CREW MAN
7
3
2
1
M487
SLEEP
EAT
SLEEP
M487
SO15 PHOTO
M487
EAT
M487
EAT
EAT
SO15 FEED & PHOTO
ASSIST MO18
MO18
M487
M487
EAT
EAT
EAT
M487
M487
SO15 PHOTO
SLEEP
M487
M487
SO15 FEED & PHOTO
M487
8
3
2
1
EAT
EAT
EAT
TO03
M487
SLEEP
SLEEP
SO15 PHOTO
M487
EAT
EAT
EAT
SO15 FEED & PHOTO
M487
M487
ASSIST MO18
M487
MO18
ASSIST MO18
MO18
EAT
EAT
EAT
M487
SO15 PHOTO
SLEEP
M487
M487
SO15 FEED & PHOTO
M487
ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
130
131
132
133
134
135
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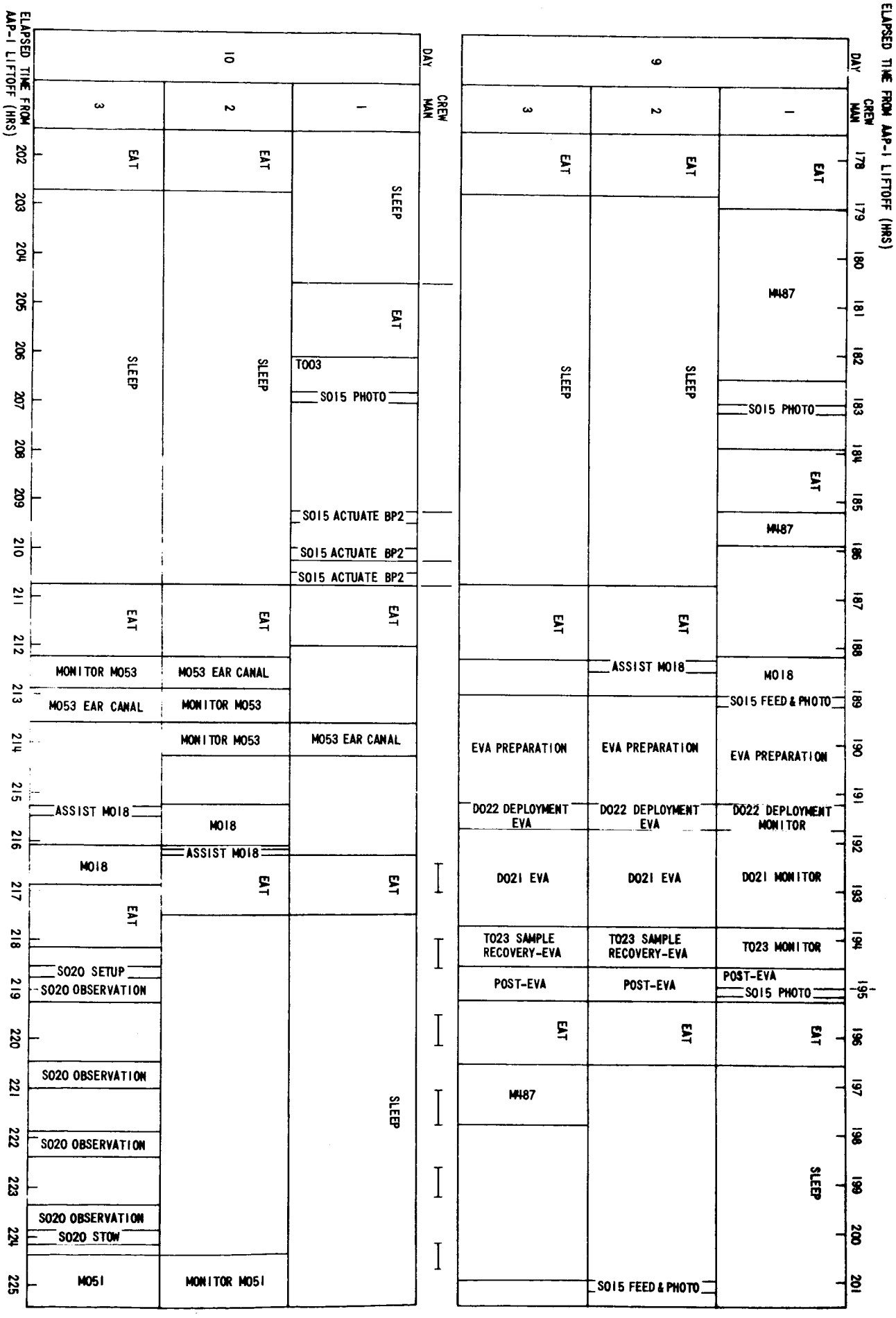
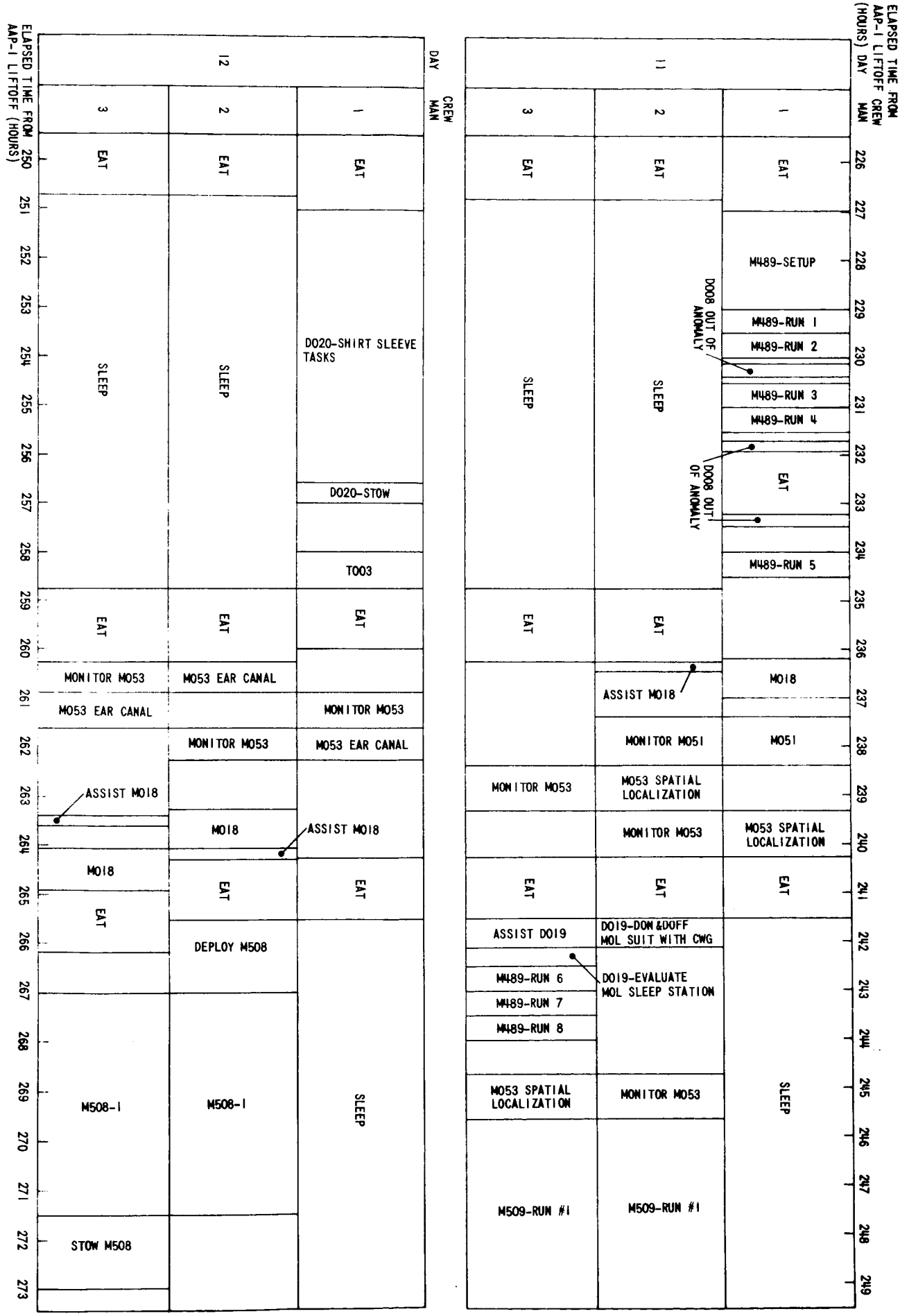
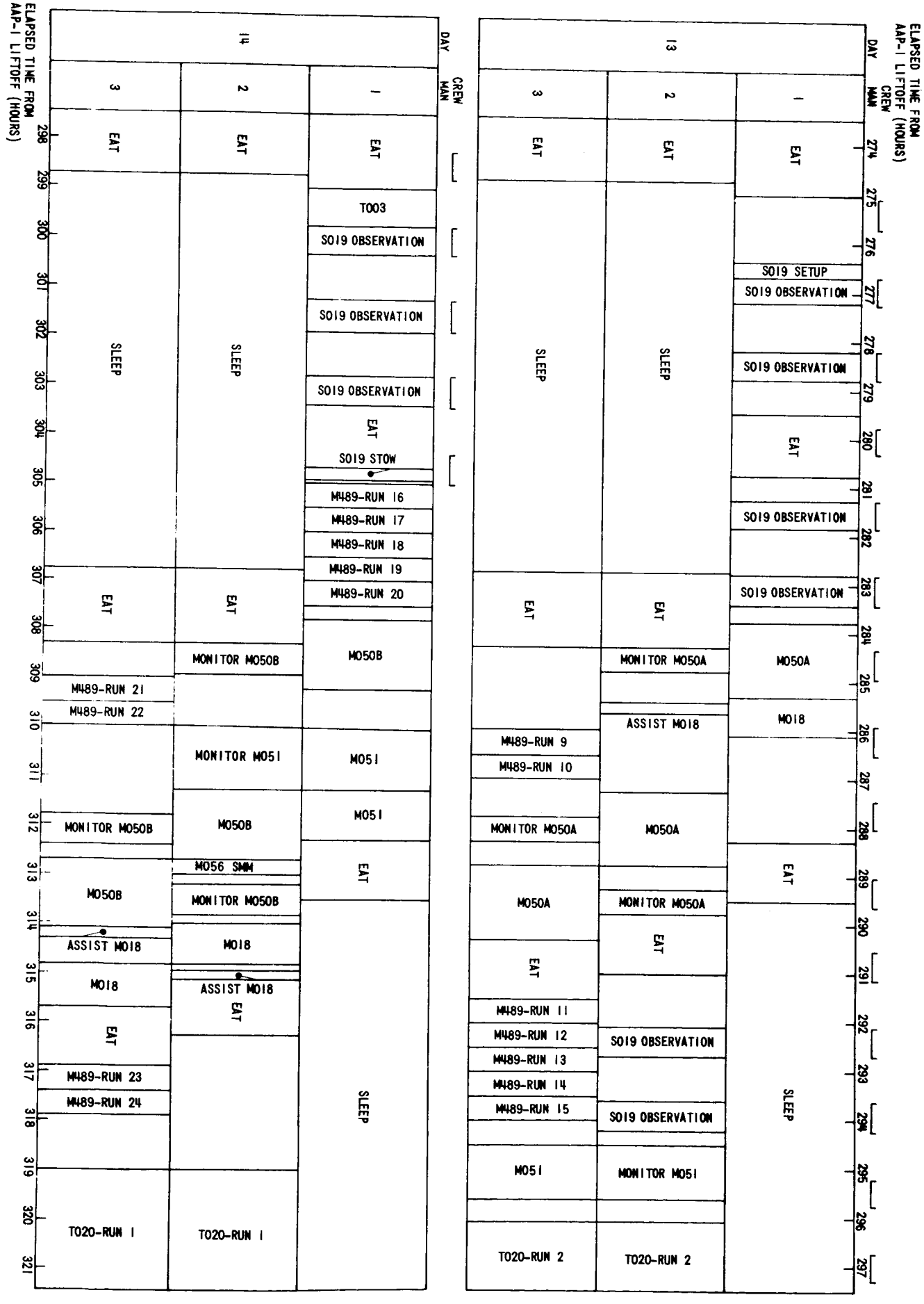
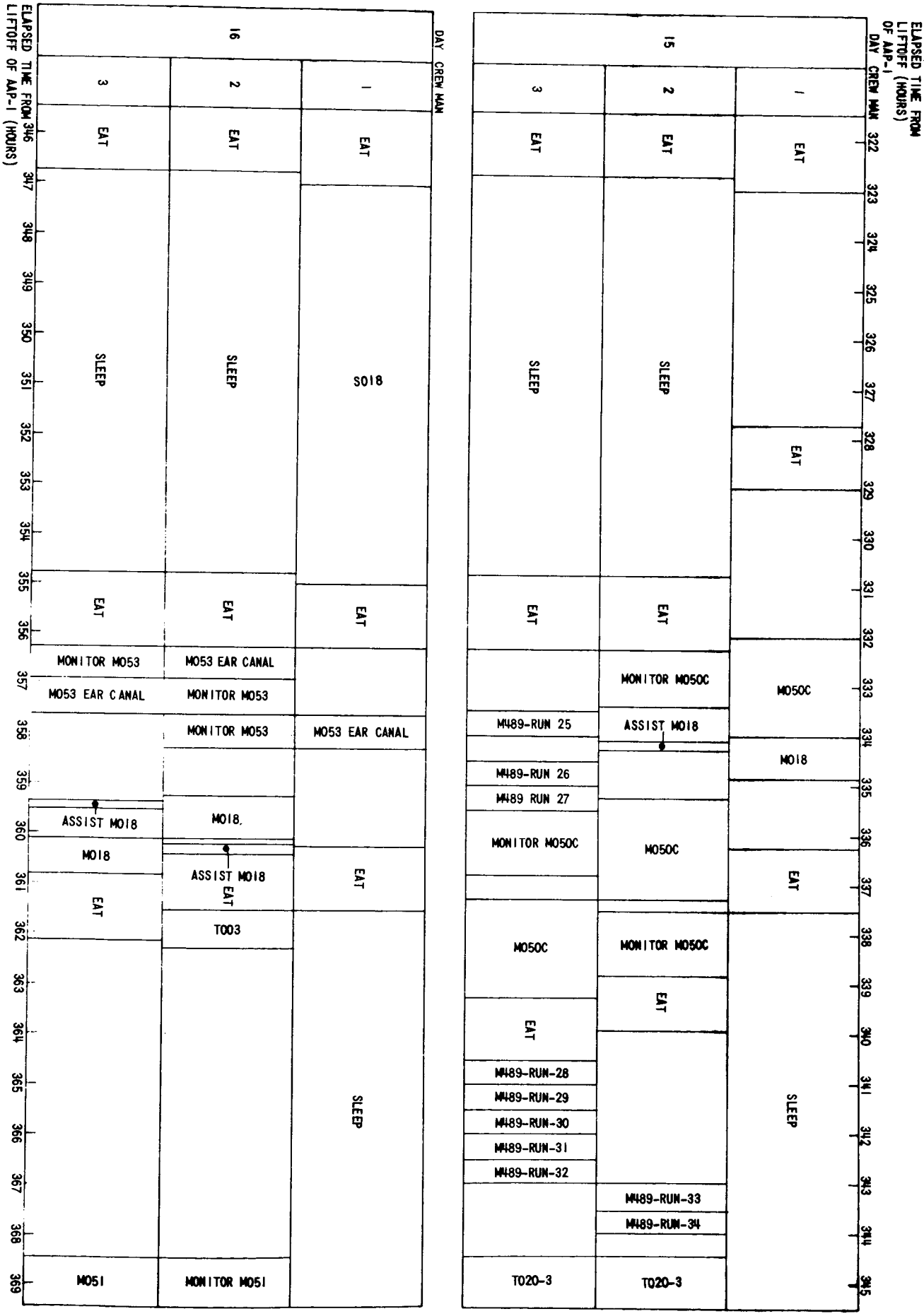

ELAPSED TIME FROM AAP-1 LIFTOFF (HRS)
DAY
CREW MAN
9
10
1
2
3
EAT
SLEEP
M487
SO15 PHOTO
SO15 ACTUATE BP2
SO15 FEED & PHOTO
ASSIST M018
M018
EVA PREPARATION
DO22 DEPLOYMENT EVA
DO22 DEPLOYMENT MONITOR
DO21 EVA
DO21 MONITOR
T023 SAMPLE RECOVERY-EVA
T023 MONITOR
POST-EVA
T003
M053 EAR CANAL
MONITOR M053
SO20 SETUP
SO20 OBSERVATION
SO20 STOW
M051
MONITOR M051


ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
11
12
1
2
3
EAT
SLEEP
M489-SETUP
M489-RUN 1
M489-RUN 2
M489-RUN 3
M489-RUN 4
M489-RUN 5
D008 OUT OF ANOMALY
D020-SHIRT SLEEVE TASKS
D020-STOW
T003
ASSIST M018
M018
MONITOR M051
M051
MONITOR M053
M053 SPATIAL LOCALIZATION
M053 EAR CANAL
ASSIST D019
D019-DON &DOFF MOL SUIT WITH CWG
D019-EVALUATE MOL SLEEP STATION
M509-RUN #1
DEPLOY M508
M508-1
STOW M508


ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
13
1
EAT
SO19 SETUP
SO19 OBSERVATION
SO19 OBSERVATION
SO19 OBSERVATION
EAT
SO19 OBSERVATION
2
EAT
SLEEP
MONITOR M050A
ASSIST M018
M050A
MONITOR M050A
EAT
SO19 OBSERVATION
MONITOR M051
3
EAT
SLEEP
M489-RUN 9
M489-RUN 10
M489-RUN 11
M489-RUN 12
M489-RUN 13
M489-RUN 14
M489-RUN 15
M051
T020-RUN 2
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
14
1
EAT
T003
SO19 OBSERVATION
SO19 OBSERVATION
SO19 OBSERVATION
EAT
SO19 STOW
M489-RUN 16
M489-RUN 17
M489-RUN 18
M489-RUN 19
M489-RUN 20
M050B
MONITOR M051
M051
M050B
M056 SMM
MONITOR M050B
M018
ASSIST M018
EAT
SLEEP
2
EAT
SLEEP
MONITOR M050B
M050B
MONITOR M051
M018
ASSIST M018
EAT
SLEEP
T020-RUN 1
3
EAT
SLEEP
M489-RUN 21
M489-RUN 22
MONITOR M050B
M050B
M018
EAT
M489-RUN 23
M489-RUN 24
T020-RUN 1
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
= SPACECRAFT "NIGHT"


ELAPSED TIME FROM LIFTOFF OF AAP-1 (HOURS)
DAY CREW MAN
15
1
2
3
EAT
SLEEP
MONITOR M050C
M050C
ASSIST M018
M018
M489-RUN 25
M489-RUN 26
M489 RUN 27
MONITOR M050C
M050C
M050C
EAT
M489-RUN-28
M489-RUN-29
M489-RUN-30
M489-RUN-31
M489-RUN-32
M489-RUN-33
M489-RUN-34
T020-3
T020-3
322
323
324
325
326
327
328
329
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331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
ELAPSED TIME FROM LIFTOFF OF AAP-1 (HOURS)
DAY CREW MAN
16
1
2
3
EAT
SLEEP
S018
MONITOR M053
M053 EAR CANAL
MONITOR M053
ASSIST M018
M018
T003
M051
MONITOR M051
346
347
348
349
350
351
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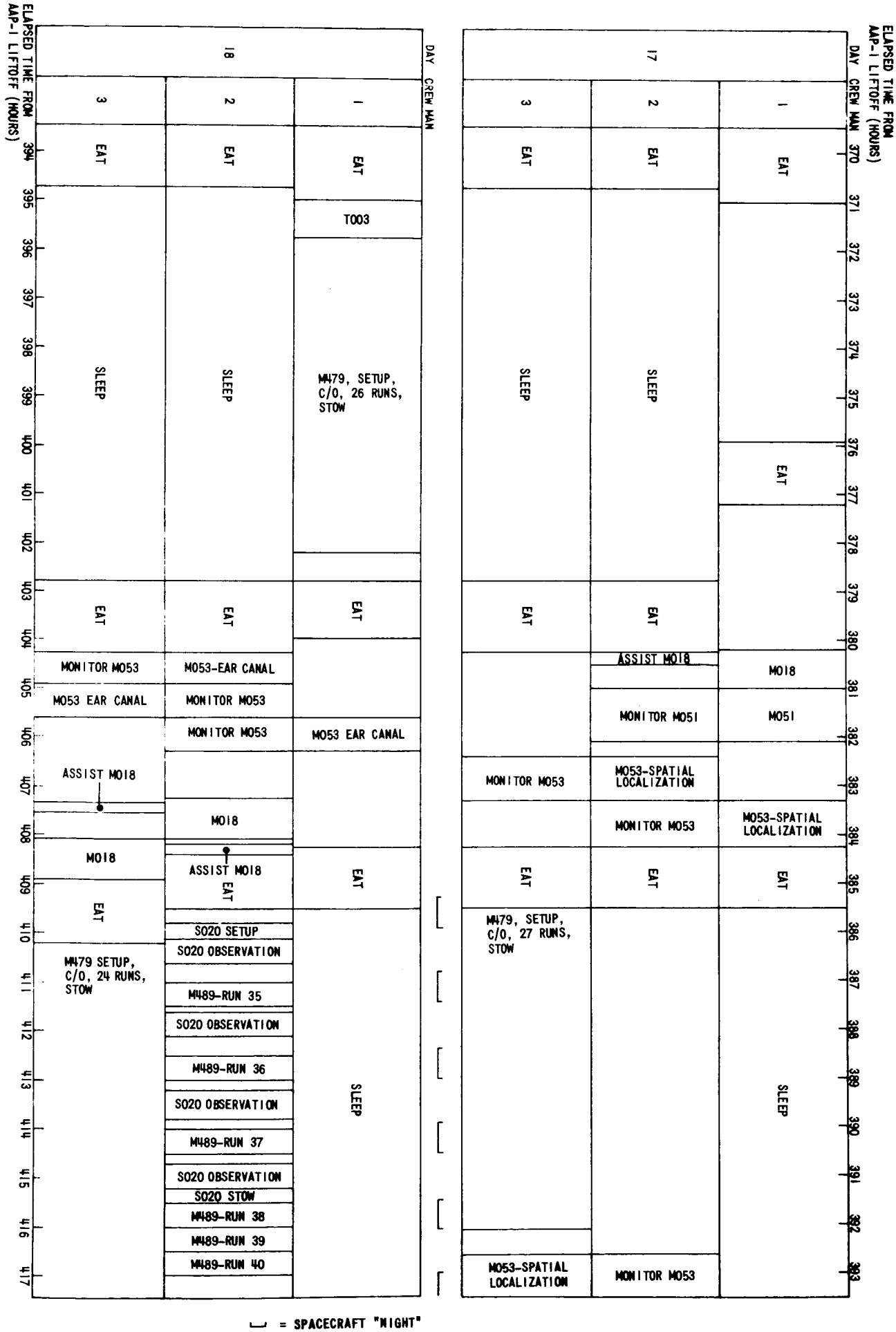
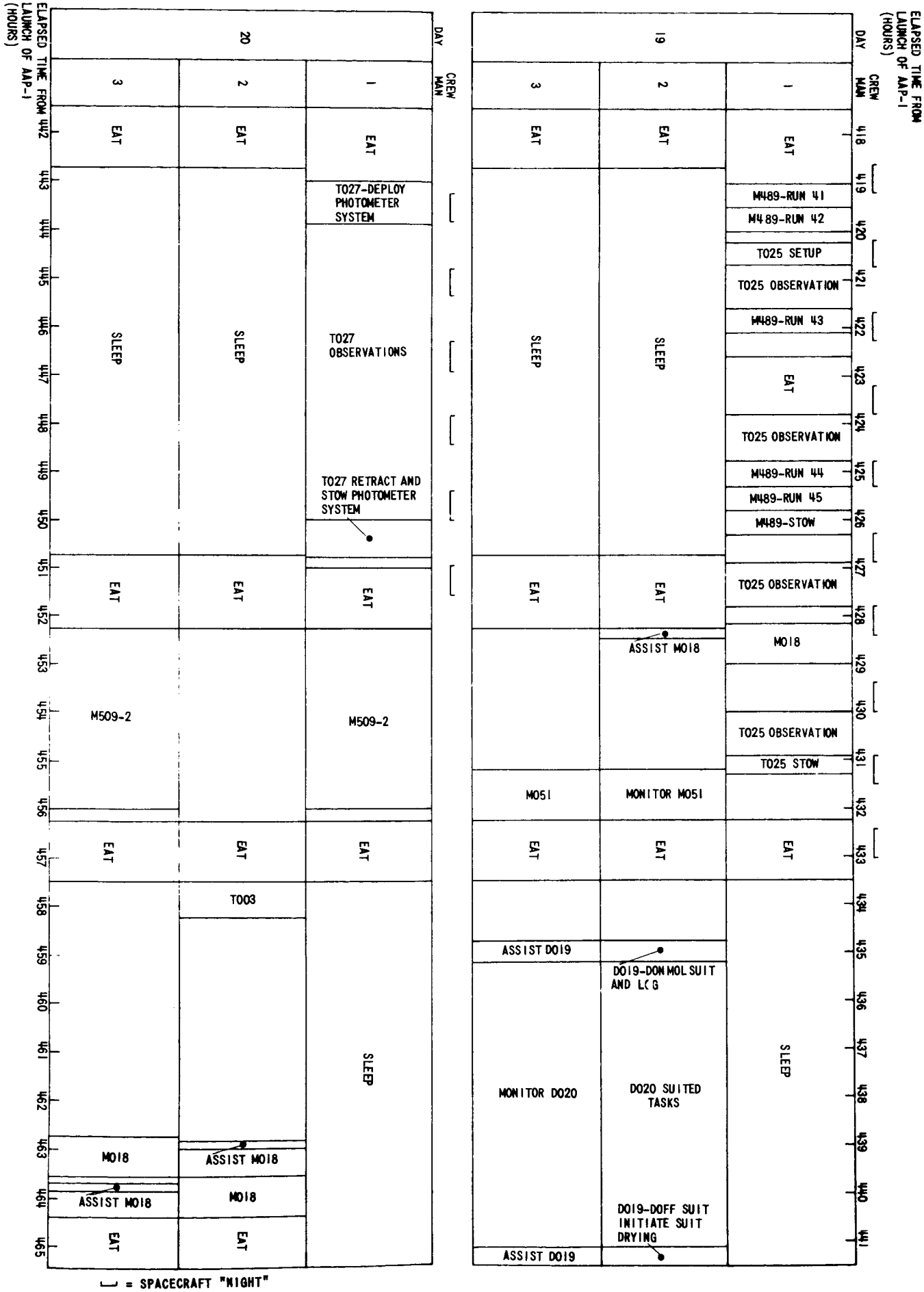
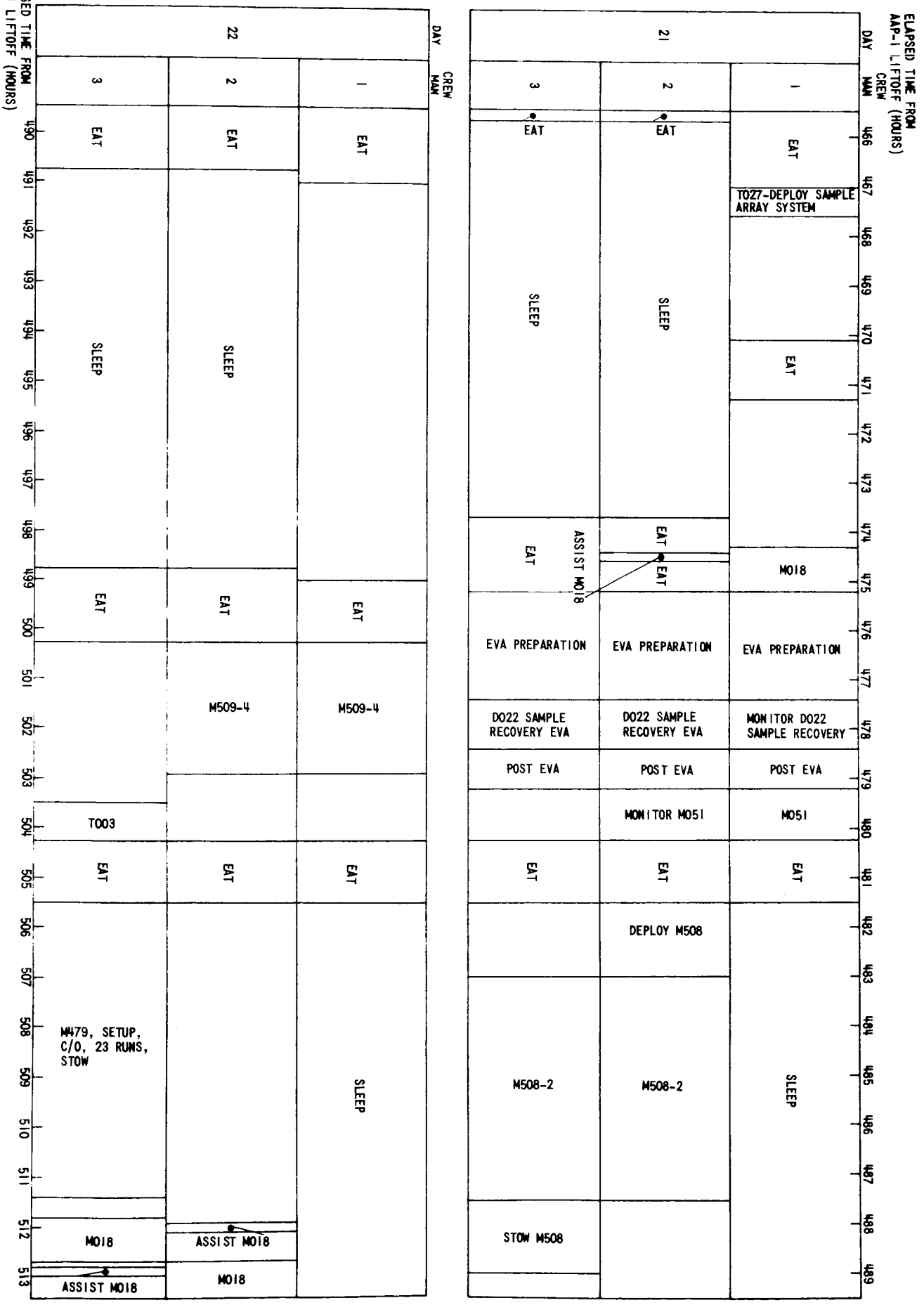
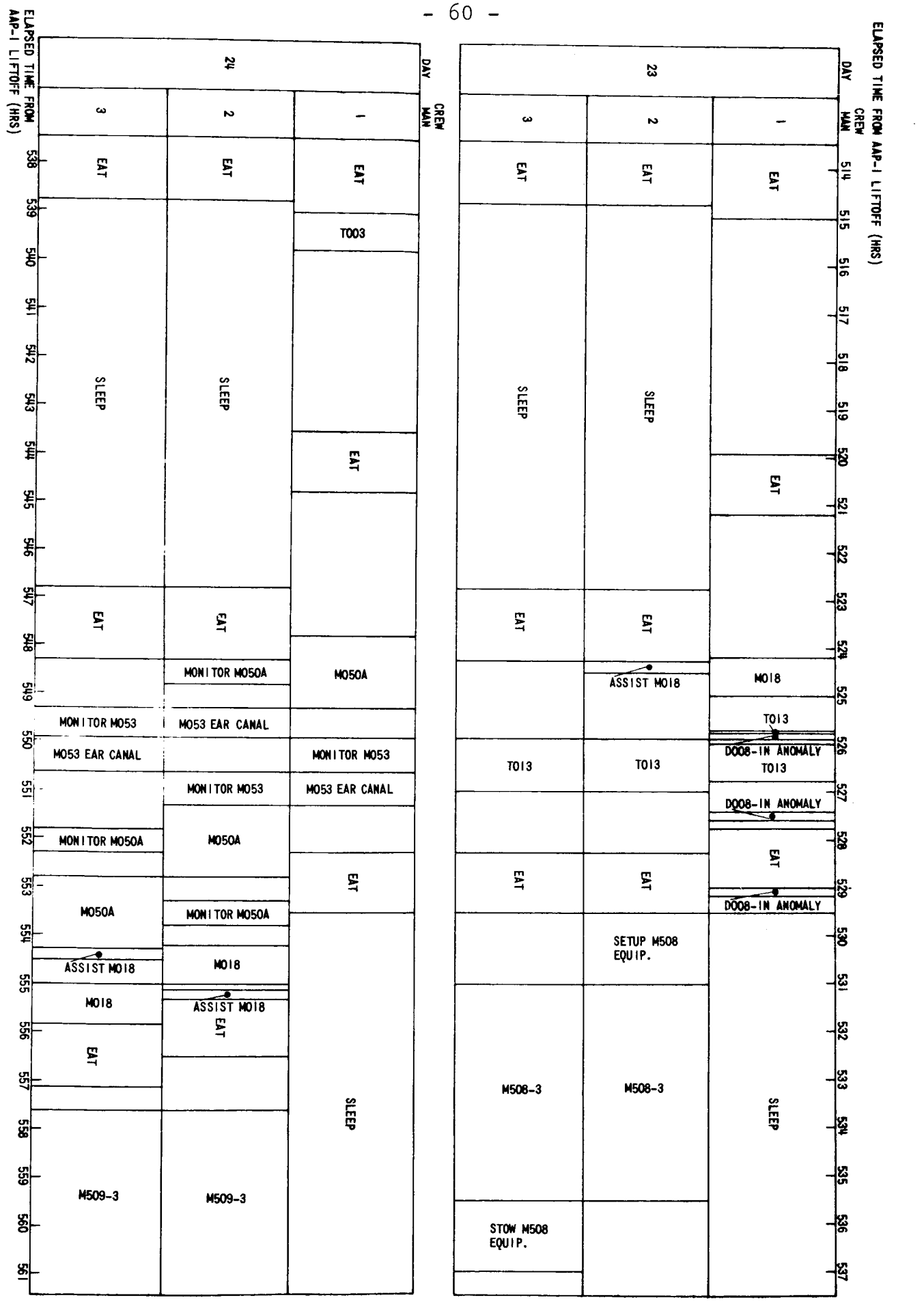

ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
17
18
1
2
3
EAT
SLEEP
T003
M479, SETUP, C/O, 26 RUNS, STOW
ASSIST M018
M018
M051
MONITOR M051
M053-SPATIAL LOCALIZATION
MONITOR M053
M053 EAR CANAL
M053-EAR CANAL
S020 SETUP
S020 OBSERVATION
M489-RUN 35
M489-RUN 36
M489-RUN 37
M489-RUN 38
M489-RUN 39
M489-RUN 40
M479 SETUP, C/O, 24 RUNS, STOW
M479, SETUP, C/O, 27 RUNS, STOW
= SPACECRAFT "NIGHT"


ELAPSED TIME FROM LAUNCH OF AAP-1 (HOURS)
DAY
CREW MAN
19
20
1
2
3
EAT
SLEEP
M489-RUN 41
M489-RUN 42
T025 SETUP
T025 OBSERVATION
M489-RUN 43
M489-RUN 44
M489-RUN 45
M489-STOW
M018
ASSIST M018
T025 STOW
M051
MONITOR M051
ASSIST D019
D019-DON MOL SUIT AND LCG
MONITOR D020
D020 SUITED TASKS
D019-DOFF SUIT INITIATE SUIT DRYING
T027-DEPLOY PHOTOMETER SYSTEM
T027 OBSERVATIONS
T027 RETRACT AND STOW PHOTOMETER SYSTEM
M509-2
T003
= SPACECRAFT "NIGHT"


ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
21
22
1
2
3
EAT
SLEEP
TO27-DEPLOY SAMPLE ARRAY SYSTEM
M018
ASSIST M018
EVA PREPARATION
DO22 SAMPLE RECOVERY EVA
MONITOR DO22 SAMPLE RECOVERY
POST EVA
MONITOR M051
M051
DEPLOY M508
M508-2
STOW M508
M509-4
TO03
M479, SETUP, C/O, 23 RUNS, STOW


ELAPSED TIME FROM AAP-1 LIFTOFF (HRS)
DAY
CREW MAN
23
1
2
3
EAT
SLEEP
ASSIST M018
M018
T013
D008-IN ANOMALY
SETUP M508 EQUIP.
M508-3
STOW M508 EQUIP.
514
515
516
517
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527
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531
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533
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535
536
537
24
T003
M050A
MONITOR M050A
MONITOR M053
M053 EAR CANAL
M509-3
538
539
540
541
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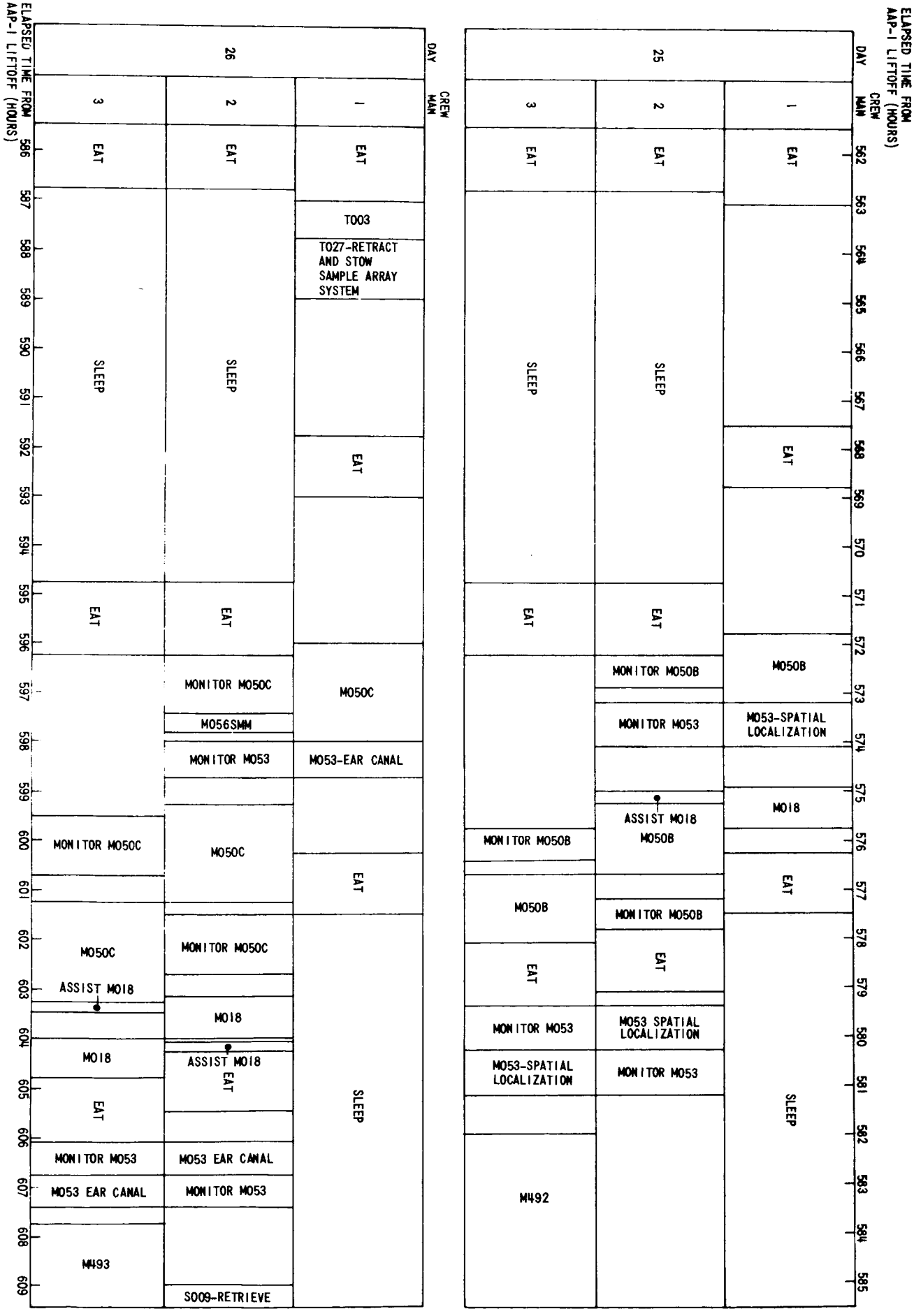
ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
25
3
2
1
EAT
SLEEP
MONITOR M050B
M050B
MONITOR M053
M053-SPATIAL LOCALIZATION
ASSIST M018
M018
M053 SPATIAL LOCALIZATION
M492
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
26
T003
T027-RETRACT AND STOW SAMPLE ARRAY SYSTEM
MONITOR M050C
M050C
M056SMM
MONITOR M053
M053-EAR CANAL
M053 EAR CANAL
M493
S009-RETRIEVE
586
587
588
589
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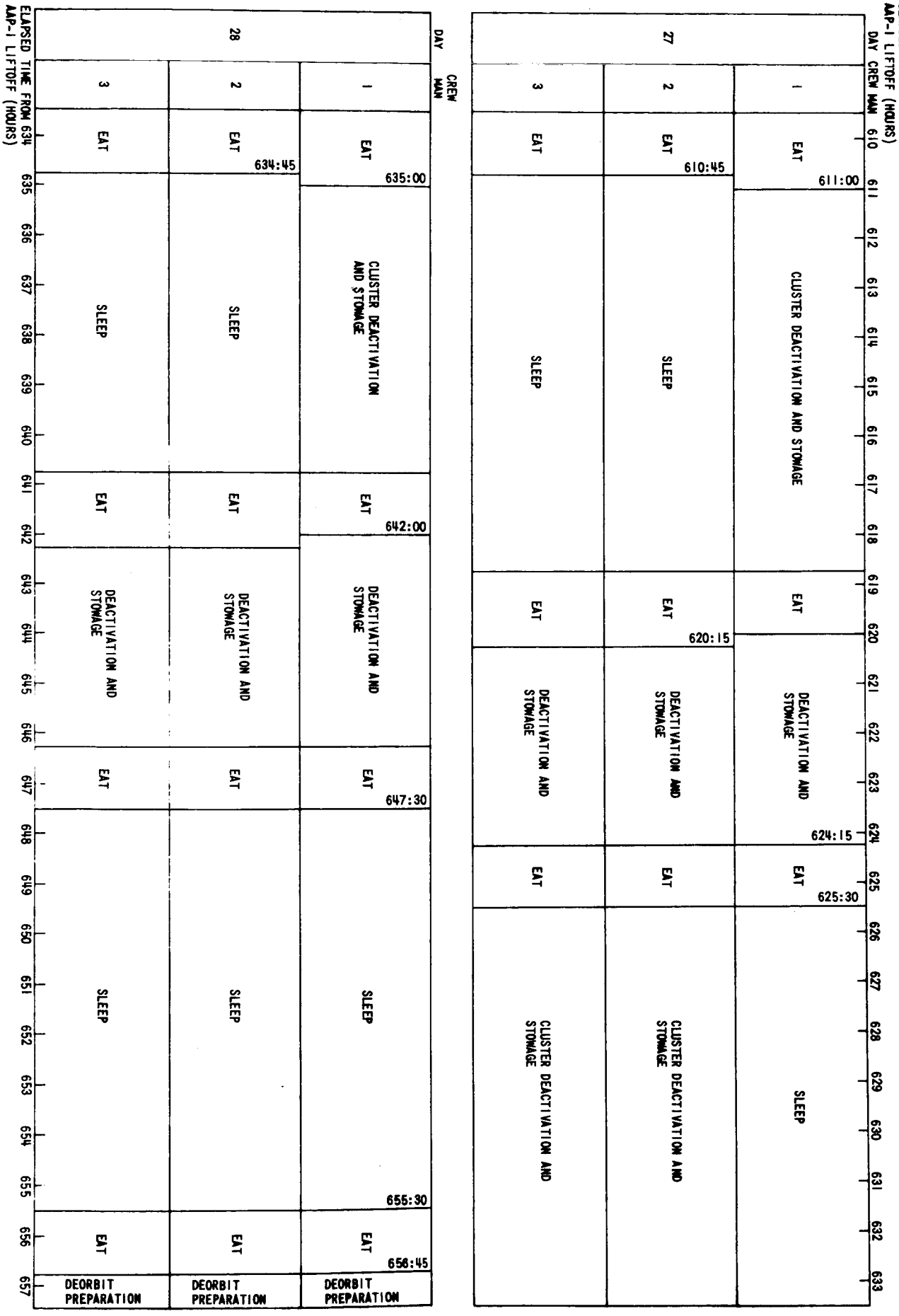
ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
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631
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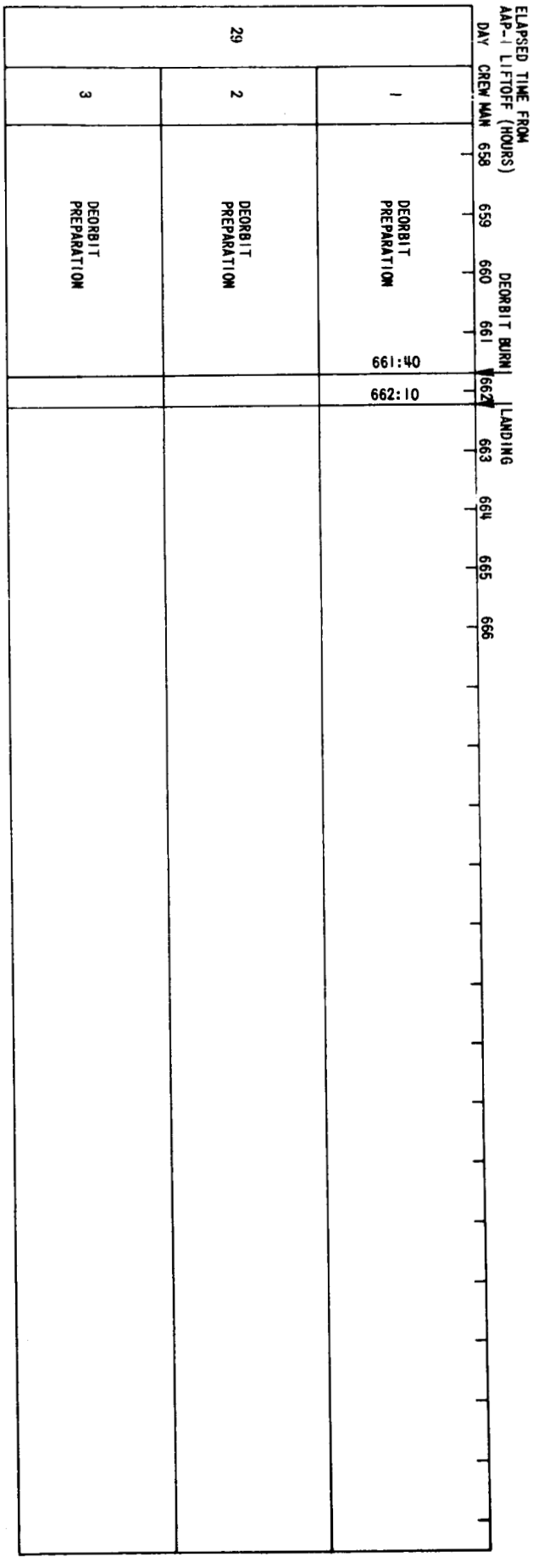
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
27
1
EAT
611:00
CLUSTER DEACTIVATION AND STOWAGE
2
EAT
610:45
SLEEP
3
EAT
SLEEP
EAT
620:15
DEACTIVATION AND STOWAGE
EAT
624:15
DEACTIVATION AND STOWAGE
EAT
625:30
SLEEP
CLUSTER DEACTIVATION AND STOWAGE
28
1
EAT
635:00
CLUSTER DEACTIVATION AND STOWAGE
2
EAT
634:45
SLEEP
3
EAT
SLEEP
EAT
642:00
DEACTIVATION AND STOWAGE
EAT
647:30
DEACTIVATION AND STOWAGE
EAT
655:30
SLEEP
EAT
656:45
DEORBIT PREPARATION
DEORBIT PREPARATION
DEORBIT PREPARATION


ELAPSED TIME FROM AAP-1 LIFTOFF (HOURS)
DAY
CREW MAN
658
659
660
661
662
663
664
665
666
DEORBIT BURN
LANDING
29
1
DEORBIT PREPARATION
661:40
662:10
2
DEORBIT PREPARATION
3
DEORBIT PREPARATION

8.0 Analysis of Crew Activity Sequence

This section discusses the extent to which crew-time requirements imposed by mission parameters, groundrules, and experiments have been met in the crew timelines presented above.

8.1 Experiments

All experiments assigned to AAP-1 and AAP-2 by ML Program Directive 3C* appear in the crew timelines with the exception of:

1. those experiments for which no in-flight crew time is required (S027, M415, T018),

2. those experiments for which required crew participation would be determined in "real time" during the operational mission (T004, S065), and

3. Experiment D017 which has been cancelled by the principal investigator.

All experiments appearing in the crew activity sequence have been allocated at least as much time as is required by the experiment time-definitions compiled above with the exception of M508, runs 3, 4, and 6 (Litton Hard Suit).

8.2 Scheduling Groundrules

The scheduling guidelines and assumptions stated previously are adhered to in the crew activity sequence with the exceptions and qualifications noted in this section.

8.2.1 Sleep Periods

The sleep periods assigned to each crewman in the crew activity sequence are shown in Figure 1. In general, crewmen 2 and 3 are scheduled to sleep simultaneously; crewman 1 sleeps when the other crewmen are awake. The preflight sleep cycle of crewmen 2 and 3 is preserved with only minor variations until Day 28: at that time a normal sleep period is terminated after 6 hours and an atypical sleep period commences ∿7 hours later. This "phase-shift" in sleep cycles brings all 3 crewmen "into phase" to permit deorbit, entry, and recovery with all awake. The preflight sleep cycle of crewman 1 is "phase-shifted" on Day 2 of the mission to initiate the typical staggered sleep schedule which is employed throughout most of the mission.

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*Reference 1

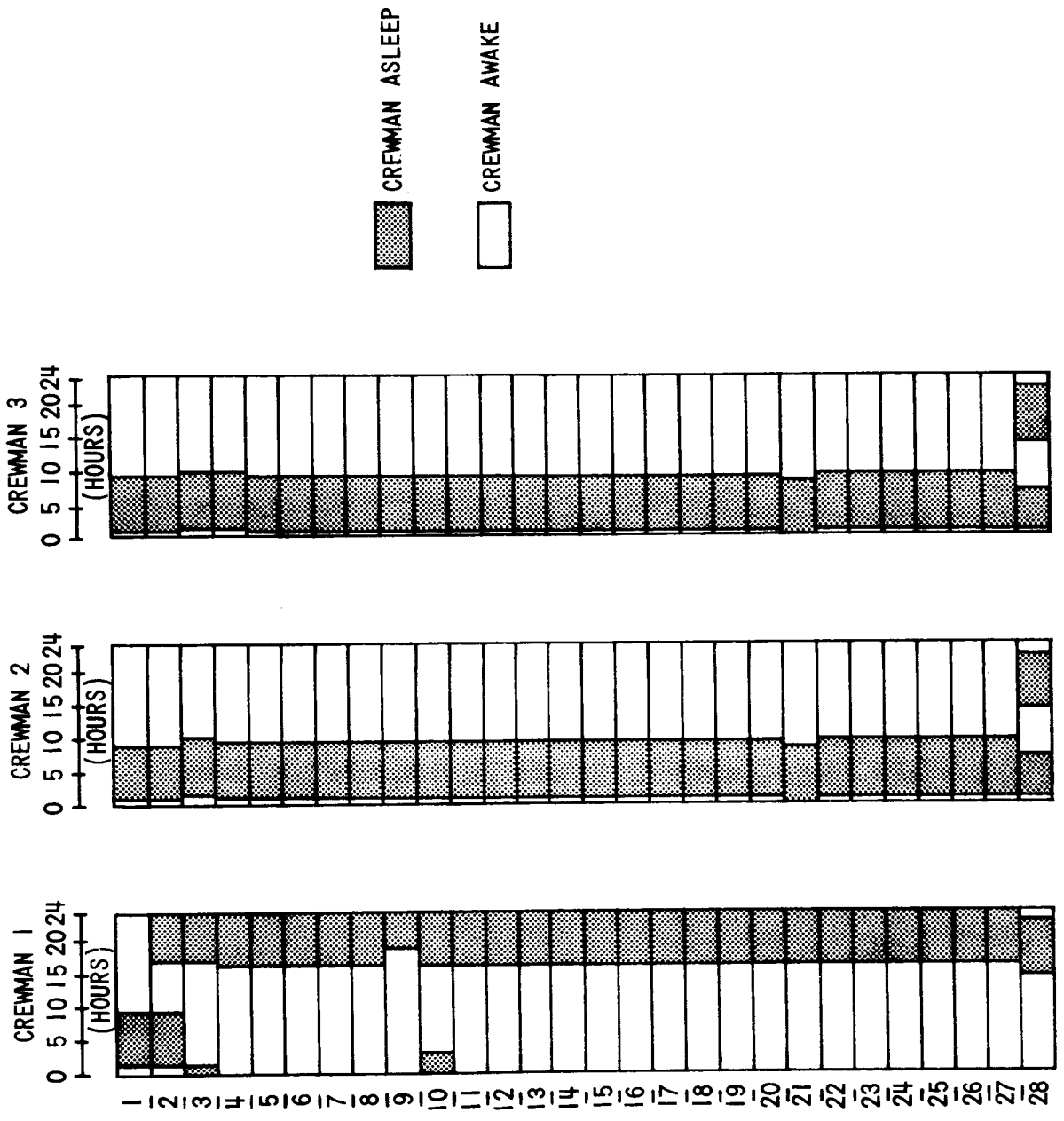

FIGURE 1. SLEEP PERIODS ALLOCATED TO EACH CREWMAN DURING THE AAP-1/AAP-2 MISSION

Thereafter the sleep cycle of crewmen is maintained with only minor variations except during Day 9 where initiation of a normal sleep period is delayed ∿3 hours by the first EVA, in which crewman 1 participates as monitor in the Command Module.

8.2.2 Unscheduled Time

Unscheduled time for each crewman throughout the mission is shown in figures 2, 3, and 4. On each day between completion of OWS activation, i.e., completion of Experiment M487 (Day 9), and the start of cluster deactivation preparations (Day 27), at least 3-1/2 hours/man of unscheduled time remain for personal and systems housekeeping with the following exceptions:

Crewman	Day	Unscheduled Time (hours:minutes)
1	20	0:27
2	21	1:55
.	24	3:10
3	21	3:05

In only one instance (crewman 1 on Day 20) is the amount of unscheduled time less than the 1.5 hr/man/day required by groundrule for personal housekeeping.

8.2.3 Meals

Three meals of the required duration are provided for each man during each mission day; "breakfast" immediately follows each sleep period and "dinner" immediately preceeds each sleep period except for the first inflight meal of each man which begins immediately after preparations for initial pressurization of the AM/MDA (7:40 GET).

All crewmen eat simultaneously or have overlapping meal periods except on days 5, 9, 11, 19, 23 when only two of the three meals are eaten simultaneously by all crewmen and on days 3, 4, 7, 13, 14, 15, 24, 25, 26 when only one meal is eaten simultaneously by all crewmen.

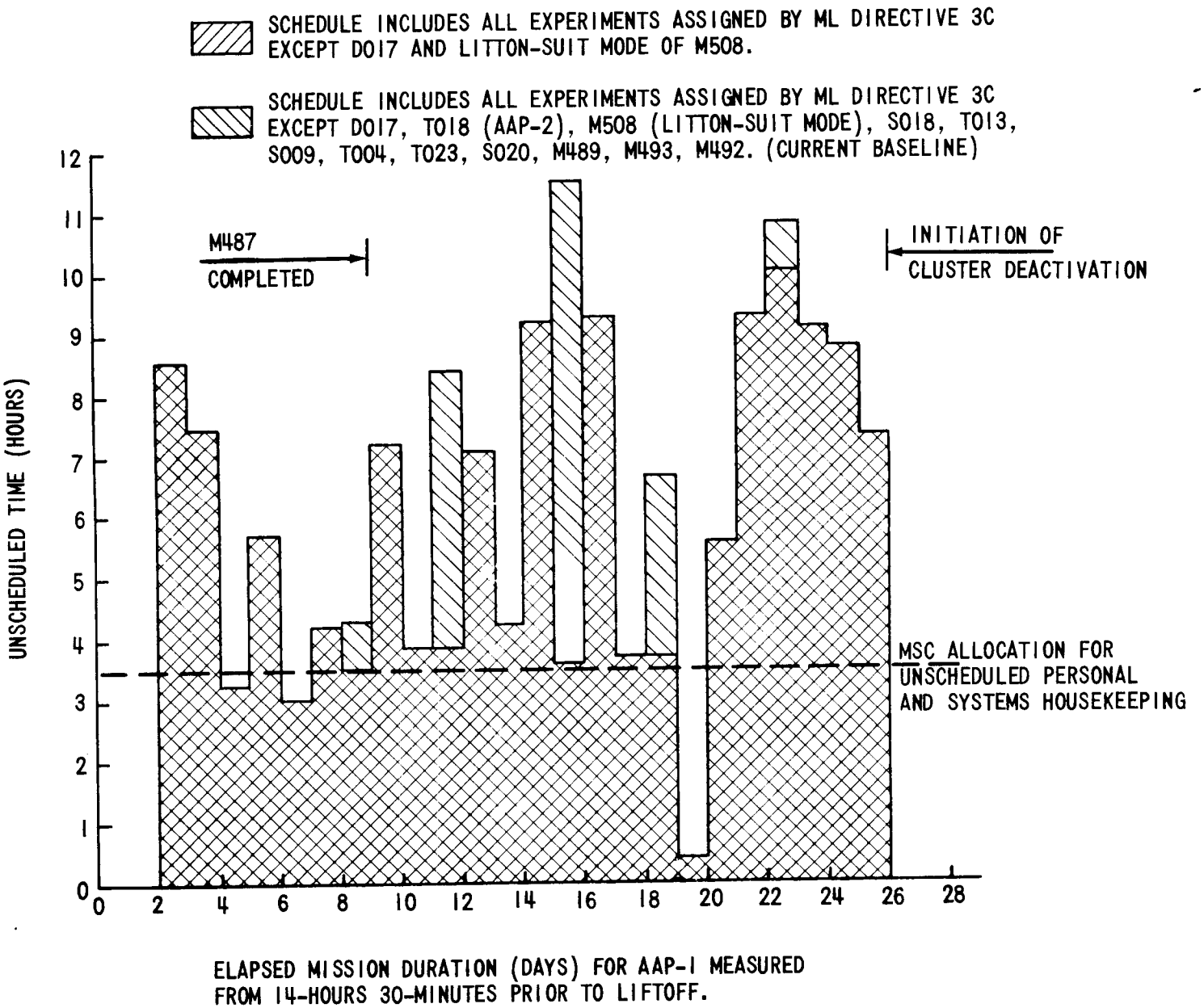

FIGURE 2. UNSCHEDULED TIME FOR CREWMAN 1 DURING THE AAP-1/AAP-2 MISSION

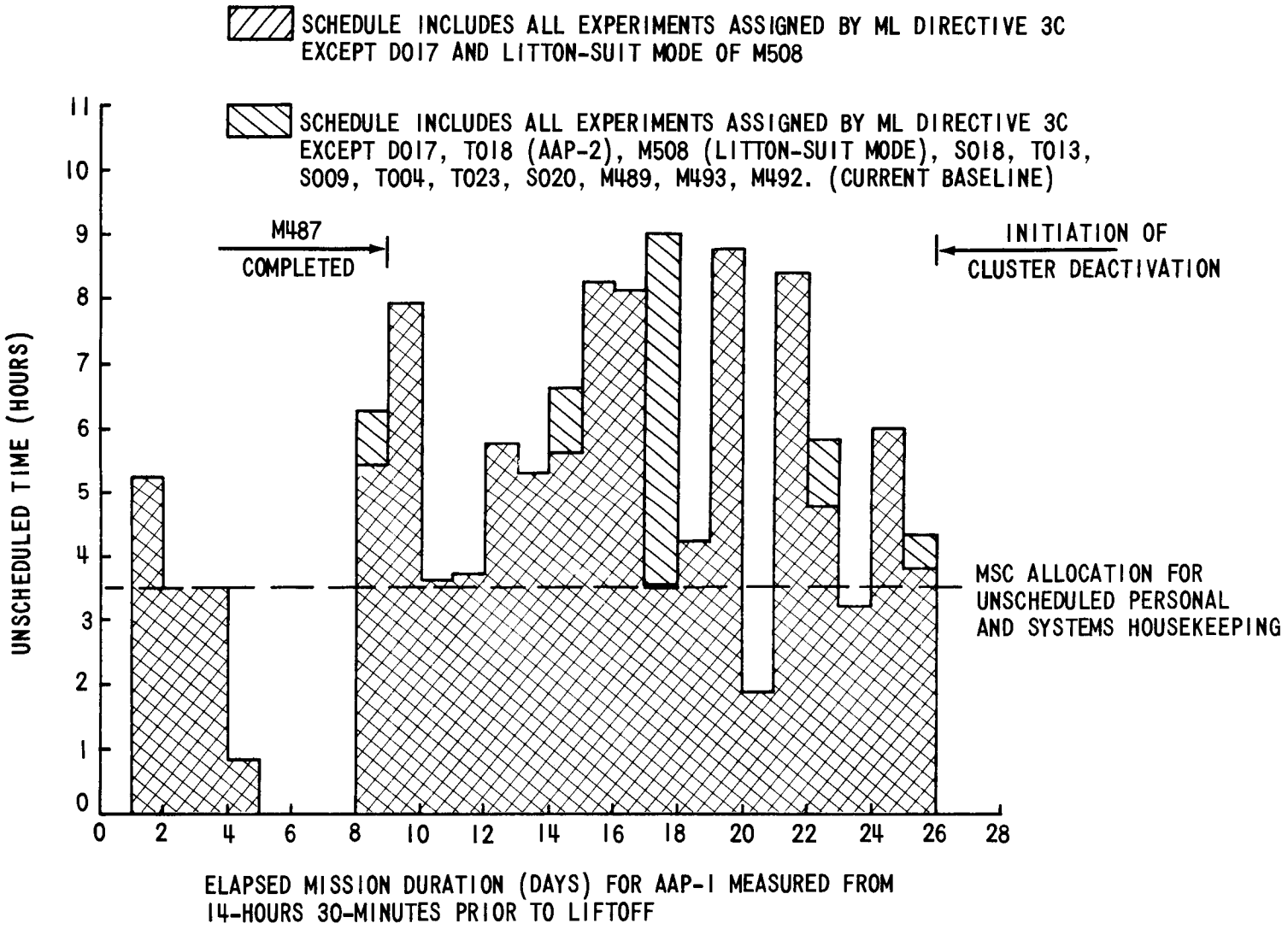

FIGURE 3. UNSCHEDULED TIME FOR CREWMAN 2 DURING THE AAP-1/AAP-2 MISSION

NOTE: CREWMAN 2 IS ASSUMED TO BE THE PHYSICIAN-ASTRONAUT OF EXPERIMENT M051.

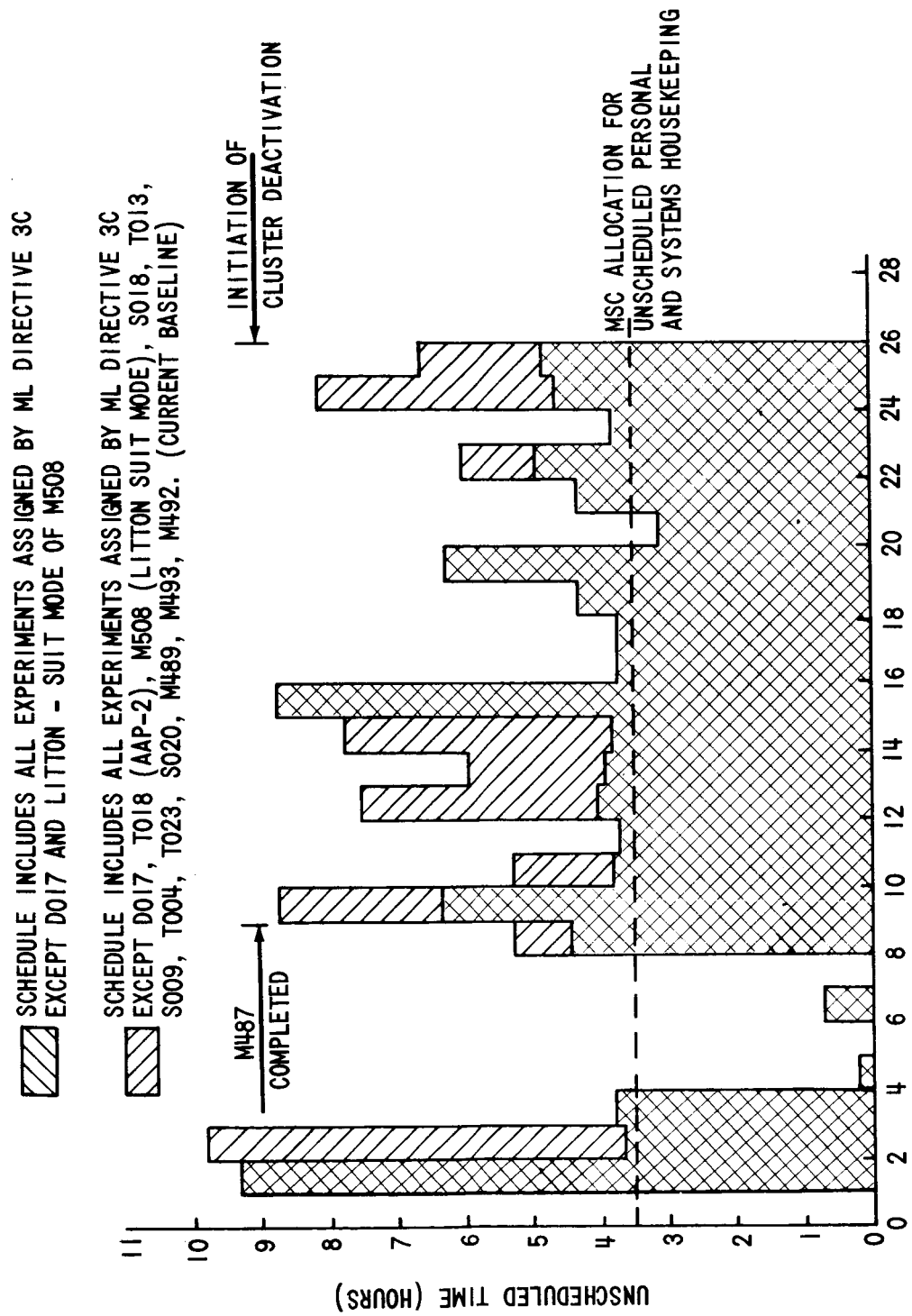

FIGURE 4. UNSCHEDULED TIME FOR CREWMAN 3 DURING THE AAP-1/AAP-2 MISSION

8.2.4 Rest and Mission Evaluation Days

In AAP, MSC has followed the practice of allocating every seventh day for rest and mission evaluation, with essentially no experiments performed on such days (Reference 7). In constructing the crew activity sequence of this study, it was not found possible to follow that practice and to still schedule all assigned experiments. Unscheduled time remaining available for rest and mission evaluation is shown in figures 2, 3, and 4.

8.2.5 Command Module Occupancy

The crew activity sequence is consistent with continuous manning of the Command Module except during a 14 minute period on Day 19.

8.2.6 Maximum EVA Duration

The duration of the first EVA (Day 9) in the above crew activity sequence is 20 minutes longer than MSC's maximum permissible duration of 3 hours. The recent deletion of T023 from the baseline, however, will permit the EVA period on Day 9 to be shortened to 2-1/2 hours.

9.0 Effect of Recent Elimination of Certain Experiments from the Baseline Mission

Experiments S018, T013, S009, T023, S020, M489, M493, and M492 which are shown in the crew timelines of this study are no longer baselined for the AAP-1/AAP-2 mission. Experiments M489, M493, and M492 were among the last to be scheduled due to their low priority; their deletion therefore does not imply a gain in scheduling flexibility. As noted above, the removal of Experiment T023 has the beneficial effect of reducing the first EVA period's duration to less than 3 hours. The crew-time impact of S009, which requires only 1/2 hour of one man's time early in the mission and 1/2 hour later in the mission, was relatively insignificant; the deletion of that experiment gains little in scheduling flexibility for the remaining baselined experiments. The deletion of S020 on Day 10 creates ∿6 hours of unscheduled time for crewman 3 simultaneously with an existing and slightly longer unscheduled period for crewman 2. This period of 2 man time would be useful for mission evaluation and rest. The deletion of S020 and M489 on Day 18 creates an unscheduled period of 8 hours for crewman 2 which again may be used to advantage as a rest and evaluation period. The elimination of T013 gains each crewman 1 hour of unscheduled time: this time gain occurs simultaneously for the entire crew and adds to scarce unscheduled three-man-awake time. Crewman 1 gains an uninterrupted 8 hour period of unscheduled time by the deletion of S018.

A comprehensive view of the increase in unscheduled time resulting from all of the above deletions of experiments is shown in figures 2, 3, and 4. In no case does the additional unscheduled time provide relief on previously overscheduled days, i.e., days on which less than 3-1/2 hours of unscheduled time had been retained.

10.0 Comparison with MSC Reference Flight Plan for AAP-1/AAP-2

In April 1968, MSC issued a Reference Flight Plan* for AAP-1/AAP-2 based upon ML Directive 3C as issued in January 1968. In that study days 8, 15, and 22 were reserved for mission evaluation and therefore were not available for conducting experiments; in addition, no priority was attached to initiating the performance of essential biomedical experiments as soon as possible after MDA activation.** The resulting reference flight plan did not schedule experiments D022, M051, M469, S009, S019, S020, S065, T013, T020, or T023. Of those experiments not scheduled, the following are in the AAP-1/AAP-2 baseline at this writing: D022, M051, S019, S065 (S101), T020. Experiments D020 and M508 were scheduled, but not in their entirety.

11.0 Conclusions

The primary conclusion of this study is that the experiments currently assigned to AAP-1/AAP-2 are compatible with crew-time availability:*** that conclusion must, however, be understood in the context of the scheduling ground rules employed, and in the extent to which such groundrules were observed. Groundrules and assumptions have been explicitly stated above and need not be repeated; significant departures from those rules and assumptions are, however, worth emphasizing here:

1. In four separate instances, the allocation of unscheduled time to each crewman fell below 3-1/2 hours per day. In one instance (crewman 1, Day 20) the amount of unscheduled time remaining is 27 minutes. Such tight scheduling should, of course, be avoided in a schedule intended for use in an operational flight. Additional work is therefore necessary to attempt to alleviate the problem by rescheduling, by modifying the crew-time requirements of one or more experiments, by modifying scheduling groundrules, or, if necessary, by deleting one or more experiments from the mission.

2. All crewmen eat all meals simultaneously on 15 days of the mission, only 2 meals simultaneously on 5 days, and only one meal simultaneously on 9 mission days.

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*Reference 7

**Other essential groundrules were, however, substantially the same as those employed in the present study.

***This assumes the Litton Suit portions of M508 are deleted.

3. It was not found possible to allocate days exclusively for mission evaluation consistent with the scheduling of all currently assigned experiments. Appreciable amounts of unscheduled time over and above personal and systems housekeeping requirements are, however, available, as shown in figures 2, 3, and 4.

The scheduling exercise carried out in this study indicates the desirability of incorporating all experiments currently assigned to AAP-1/AAP-2 into a baseline operational flight plan, provided systems support requirements can be met. Such an operational flight plan would, of course, require periodic updating as experiment crew-time requirements are revised to reflect changes in experimental procedures and the results of experiment simulations.

12.0 Acknowledgments

The writer is indebted to Mr. A. B. Baker for his calculations of spacecraft day/night cycles and to Mr. M. S. Feldman who supplied many of the experiment descriptions employed in this study. Mr. B. E. Ferguson - MSC/CF34 provided valuable insight into flight planning for AAP now in progress at MSC.

1025-DJB-dcs

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17. EIRD for Experiment D020, MSFC, May 29, 1968.

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*EIRD = Experiment Integration Requirements Document

References (contd.)

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20. EIRD for Experiment M509, MSFC, April 2, 1968.

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22. EIRD for Experiment T020, MSFC, July 16, 1968.

23. EIRD for Experiment T003, MSFC, February 14, 1968.

24. EIRD for Experiment M479, MSFC, June 20, 1968.

25. EIRD for Experiment T013, MSFC, March 15, 1968.

26. EIRD for Experiment T004, MSFC, July 8, 1968.

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